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Examination of some Questions relative to Transportation. By M. LAMARLE, Chief Engineer "des Ponts et Chaussées." Translated by J. BENNETT.

(Continued from page 224.)

IT is natural, where no appreciable economy can be found in expense of transportation, that we should reject all difference in tariffs.

9. We have now to examine what is upon this point, the special right, created by the conditions of contract accepted by the companies. These acts, drawn up in 1844 and 1845, have been revised in later years, and the article relative to the reductions of tariff, has received in 1857 a great change.

The ancient conditions had the following clause in relation to private bargains:

"In case the Company shall accord to one or more forwarders, a reduction upon any of the prices of the tariff, before putting in execution, it must inform the administration, and the latter shall have the right to declare the reduction once agreed upon, as binding upon all forwarders."

The new article reads as follows:

"When the company shall judge proper, whether for the whole distance, or for a partial distance of the railroad, to reduce with or without conditions below the limit determined by the tariff, the taxes it is authorized to collect, the reduced taxes shall not be raised till after a

delay of three months at least for passengers, and one year for merchandise.

"Every modification of tariff proposed by the companies shall be announced a month beforehand by postings; the collection of the modified tariffs shall not be made, except with the confirmation of the upper administration, conformably to the dispositions of the ordonnance of 15th Nov., 1846.

"The collection of taxes must be made without distinction and without favor. Every private compact which has for effect the granting to one or more forwarders a reduction upon the approved tariffs, is *formally forbid:* this disposition, however, is not applicable to compacts made between the government and companies for the interest of public service, nor to reductions which shall be granted by the companies to indigents.

"In case of lowering the tariff, the reduction shall be made proportionally upon the toll and upon transportation."

We see from these citations that the public administration has, since 1845, recognised the danger of private compacts, since it has decided to pronounce their formal interdiction. As to reductions of tariffs, with or without conditions, they must in all cases be publicly announced a month in advance, to be confirmed by the government, and applied without distinction or favor. The liberty of companies, is thus subjected to numerous restrictions; they can only proceed but with general measures, and their proposals before being applied, must be submitted to the double proof of public observation, and the inspection of the government, free to confirm or reject them.

Such is the special right created by the contracts, with a wise and legitimate foresight. Never was the protecting intervention of public authority more necessary or better justified. We have seen in the example already cited, that the Northern Company authorized to collect 27·90 fr. upon oil from Quiévrain to Paris has reduced its tariff to 10·50 fr.; it could still, without loss, go below this figure; but is it not an enormous power, this faculty of increasing at will by 17·40 fr. the price of a ton of oil, which is hardly worth 14 fr. at the mine? If the company, supposed to act free without control upon its tariffs, see fit to specially favor the Belgian mines, might it not grant them an immediate premium, far superior to the customs upon oil, 1·50 fr., and so render completely illusory the protection of the national work, which should be guaranteed? Would it not depend upon it also to artificially render the conditions of industrial production, better at Paris and its suburbs, than at the intermediate places, Amiens for example, thus upsetting all geographical relations, and destroying the best established positions? It would suffice to maintain for these localities, the maximum tax of tariff, 13·20 fr., and to grant to Paris and its suburbs the reduction of taxes to 10·50 fr. Is there not reason to fear the possible consequences of such a power exerted upon oil, an essential element in all fabrications? The exercise of this power would not be confined to this commodity: the great latitude resulting from the tariff for the last class, increases for the superior classes of merchandise,

because the taxes rise much more rapidly than the expenses of traction. Without exaggeration, it may be said, no association ever had at its disposal a more powerful agent upon the industry and commerce of the country. From this results the stern necessity, consecrated by the conditions of their charter, of an elevated control to preside over the reductions of tariffs, whose consequences may be so favorable or disastrous, as they are inspired with a regard for the general interest, or with the too common and egotistic suggestions of private interest.

The public administration being invested with the right of confirming the proposed reductions of companies, may undoubtedly reduce the *differential element* of tariffs to the limit which we have indicated as a *maximum*, to wit: the amount of economies in the cost of traction, from the accepted conditions, relatively to the length, the mass, and the distribution of transportation. It can and should in our opinion, reject in so far as *exceptional*, or render *general* every reduction above this figure.

It may possibly be objected, that thus operated, the reductions may not bear proportionally upon the tolls and transportation. This would not be exact; for nothing forbids a distribution of the total amount of reduction determined in each case, proportionally to the figures of the two taxes. This estimation at a relative value is not at present effected in the modified tariffs, and the reason is easily found. It has in fact a practical and possible application only in rare cases, where a company uses its carriages upon a route of which it is not the grantee. Whatever may be the force of such an objection so easily raised against our proposal, the distribution in question should never for an instant be opposed to the principle which governs this discussion, the rigorous obligation to maintain and hold safe, the fundamental base of our legislation, the equality of all as to taxation.

10. Railroad Companies cannot be compared with private enterprises. Most generally they act in virtue of a delegation of the public authority. Most of them have received from the state either considerable subsidies, or guaranties of interest; the only regard in which they may be compared with private industry, is in the execution of the transportation, and it is by reason of the monopoly which they enjoy for this operation that the intervention and control of the government has become indispensable.

To place, as has been sometimes done, a regulating check upon this monopoly, in the maximum limits of tariffs determined by acts of concession, is to fall into a complete illusion. These maxima are applied only to passengers and costly merchandise, and not to those commodities which are the object of the struggle with navigable routes. It would be absolutely impossible for railroads, whatever the distance of the competing line, to raise their tariffs to the maximum level of their conditions of charter; to raise the price of carrying oil between Quiévrain and Paris from 10·5 fr. to 27·9 would create an industrial revolution, and aside of the fear of inevitable evils the well-understood interest of the company would not permit it.

We will not attempt to determine, for the different cases which

may be presented, a rate of tariff suited to the maximum of net products. To do this would require us to assign exactly the law of the variations of traffic corresponding with those of the taxes; yet we will cite an example within our personal experience, which may enable us to appreciate the profits to be derived from certain raising of the tariffs.

Upon the route from Mons to Lille, the freight before the execution of the works of improvement of the lower Scarpe, stood at the rate of 8·5 fr. per ton; the total mean movement in the last years, was 260,000 tons; after the improvements upon this river, the freight fell to 4·06 fr., and the mean circulation (1839 to 1842) reached 448,000 tons. The distance from Mons to Lille being 100 kilometres (62 miles) by railroad, these two prices correspond to 0·085 fr. and 0·04 fr. per kilometre, (2·54 cts. and 1·19 cts. per mile.)

At the price of 0·04 fr., a railroad company, which should expend nearly 0·02 fr. per ton per kilometre (0·598 cts. per mile) upon such a distance, would obtain a net product of 0·02 fr. per unit, or for 448,000 tons 8960 francs.

On the other hand, at the price of 0·085 fr. the profit would be 0·065 fr. per ton per kilometre, its total, notwithstanding the corresponding reduction of traffic to 260,000 tons, would have attained a figure nearly double, or 16,900 francs.

In a similar case, there would then be a considerable advantage in raising the tariff from 0·04 fr., a figure nearly equal to the rate of the actual reductions up to 0·085 fr., a rate inferior to that of the chartered schedule of prices, even though the circulation be notably reduced by the increased cost of transportation.

The raising of the tariffs, so advantageous between certain limits to companies, is not operated suddenly: the necessary circumspection always imposed by great industrial interests, the ignorance of the precise law of the variations of traffic, the fear by too sudden a rise of reviving discouraging rivalries, all combine to urge upon companies a progressive empirical march, and an approach, by trials, to the figures which shall yield a net maximum product.

We have seen that the common roads cannot compete with railroads: when the considerable material of which the canal disposes, shall by losses, fall below the needs of circulation, commerce will not be tempted to construct costly vehicles whose ruin lays at the mercy of ulterior abatements of tariffs.

Thus the gradual increase of tolls, operated with a wise moderation, will without any risk, increase the profits of companies; they will advance necessarily towards this end, aided by the increase of freight, which will be realized at the expense of commerce upon navigable lines, as soon as their material shall have become insufficient.

A sudden increase in the cost of transportation would certainly lead to industrial and commercial catastrophes: a progressive increase would favor the transition, but would produce definite effects of the same order in making fabrications more costly, and thus checking the indus-

trial range. In being tardily brought to pass, the pressure would be none the less real, none the less fatal.

11. The maximum of chartered rates, cannot then, as we have seen, constitute a guarantee against monopoly for the transportation of heavy masses, since the interest of companies determines their holding below them. This well-understood interest will not constitute a real guarantee against an ulterior raising of the taxes, temporarily reduced in the presence of competition; and in reality there exists against the dangers which threaten the industrial interest, but one moderating efficacious action, that of the competition of navigable routes. To their existence we owe the reductions of price accorded by the companies, for many years past, and which at first were regarded as utopian: have we not heard a commission of the Belgian chambers declare in 1843, that the State railroad could not transport without loss, under 0·07 fr. per ton per kilometre, and do we not daily see the French companies working with profit at the rate of 0·03 fr. to 0·04 fr. (0·897 cts. to 1·19 cts. per mile)?

These so precious advantages for industry, which the competition of canals alone has procured, and which it alone can assure for the future, shows how great a public interest belongs to the maintenance of this fruitful rivalry. Thus the state cannot, without compromising the industry of the country, without a veritable suicide, allow the introduction in the differential tariffs of companies of favoring prices, of true premiums, for the encouragement of an interdict upon the rivers and canals, the great part of which it owns and works. The exclusive clause (clause d'abonnement), the last arm of an unbridled competition against the navigable routes, the sole effectual guarantee against the dangers of monopoly, should be strenuously repelled.

12. The suppression of these exclusive tariffs, the radical modifications which we have proposed for the differential taxes, will undoubtedly render less unequal the conditions of the strife, and will be a point gained. But still it will exist, and restrained even within these limits, the power of the railway will yet be very threatening for the future of navigable routes.

In the first year following the opening of the northern railroad, the public administration felt the necessity of improving the competing navigable routes. In the basins of the Aa and Escaut, the bases of collection were regulated, the price of tolls was reduced, and numerous improvements were perseveringly adopted in the condition of the working stock, and in the working of the lines; thanks to these tutelary measures, the boating interests were maintained, and, up to the present, its general traffic has continued to increase. Still, we have seen how much more rapid has been the progress of the railroad, and how it draws the merchandise which seemed to belong exclusively to the canals. The extension of traffic and the progressive development in the working stock of railroads, render the danger as great now as it was in 1849. As then, it has become necessary to counsel and act for the support of the navigable routes, which alone can assure the country a constant moderation of taxes upon railroads.

Well convinced of the vitality of navigation, this admirable instrument of economical transportation, we firmly believe in its ultimate powers of resistance, and we will endeavor to indicate here, with the reasons of our hope, the measures necessary to realize it.

13. The tolls with which rivers and canals are burthened, although not high in their mean rate, yet far surpass, upon some lines where there is a great competition, the amount of the expenses of maintenance. It is thus that, between Belgium and Paris, the total of navigation duties, notwithstanding the reductions already assented to, amounts to . . . 6,000,000 fr.
While the cost of maintenance of the lines to which they apply, scarcely reaches . . 800,000 "

Leaving for net products or impost, . 5,200,000 fr.

The mean net product of tolls upon all the canals directed by the state, exceeds 2800 francs per kilometre ($837 per mile), and so far exceeds the cost of maintenance. Upon the conceded routes, the difference is still greater.

If then it can be said that, upon certain lines the tolls represent at most the expense of maintenance, the assertion does not apply to the general network, and especially to the most frequented routes. There remains, then, to be made, a great reduction upon the rate of tolls, and we add that, for some of the routes, this diminution, eminently useful to the general interests, would at the same time be an act of rigorous justice.

When the state makes a new canal, it should undoubtedly seek to receive from its tolls, independently of the sums necessary for maintenance, the interest of capital devoted to its establishment. This interest, which the public treasure should obtain, under penalty of favoring, at the expense of all, the neighboring localities of the new canal, comes into its possession in different ways; first, the tolls, then the ulterior increase of direct and indirect taxes, resulting from the industrial and commercial developments produced by the circulation of the new route.

Often it happens, that the impost of tolls furnishes alone the maintenance of the way, and the interest and redemption of the capital; this is the case in the concessions. At other times, the canals are made by the localities, or paid for by them; sometimes it is a matter of expired concessions, which have effected a reimbursement of capital, or of lines executed by the state having a long time since repaid its advances, by the excess of receipts above expenses.

In the last three cases, every toll above the cost of maintenance becomes a veritable tax, unjust, because it strikes upon an instrument of production, upon a utensil; fatal, because it tends to restrict the route, and to replace the natural difficulties which it has overcome, by an artificial obstacle of tariffs. The evil resulting from their too great elevation is general: it reacts upon the commerce and industry which feed the canal; the treasury itself is often affected by the pressure

exerted by the tariffs upon the different sources of public revenue. When, on the contrary, the state or the companies lower the tariffs, the loss they experience is always inferior to the amount of the reduction, because there follows naturally from it a development of traffic, which is transferred into an increase of revenue of every kind, even of tolls. The Sambre and the canal joining the Sambre with the Oise, present a striking example of this fact; by a reduction of 25 per cent. operated upon the tariffs in 1841, the returns rose the year following from 239,048 to 449,248 francs; it has not ceased to increase up till 1849, when a new reduction, nearly similar in rate, brought the revenue from 1,200,258 to 1,406,860 francs. Thus each of these abatements of tariffs have been followed by a considerable increase of receipts, and they have not ceased to rise even till the opening of the rival railway; they had attained in 1856, a total of 2,060,273 francs, which gives, in sixteen years, an increase of eight-fold (1,829,225 francs upon 239,048 francs). We have also seen reductions made in 1849 upon the whole of the northern rivers and canals, produce, in less than five years, a total increase of 1,783,566 francs in the yield of tolls, and carried from 5,594,499 to 7,378,065 francs.

In this particular case, the advantage reaped by commerce is far superior to the reduction made upon the fees of navigation; the latter guaranties the permanence of those already granted upon competing routes; thus its effect is double, and reacts effectively upon the circulation, which the navigable routes do not traverse.

We cannot here indicate all the reductions to be made, and limit ourselves to pointing out a serious inequality which bears upon the lines of the basins of the Aa, of Escaut, and the Saint Quentin canal. Oil, placed by all the other schedules of tariffs in the last rank of taxable commodities, is here held in the first class, and pays the highest tax. It is the last vestige of the exceptional regime which these routes have so long suffered; it would be well to annul it, especially when the newly discovered oil mines of Pas-de-Calais, and the constantly increasing consumption of this combustible yield to the economy of its transportation a greater value than ever.

The facts above given, show how great is the public interest in reducing the tolls. Before leaving this subject, as a measure of the extent of advantages to be realized in this way, we would suggest that upon a single line (from Belgium to Paris), a diminution of 87 per cent. (5,200,000 upon 6,000,000 francs) might be made without changing the resources necessary for the maintenance of the various canals and rivers of which it is composed.

14. The material improvements of which navigable routes are susceptible, constitute a second class in a progress of unquestioned value. If now it is difficult to devise the establishment of any new extended canal, if, in most cases, a profound study of this kind of question leads to a negative solution,* it is otherwise, in the matter of the improvement of existing routes already traversed by a great circulation.

* The latest proposed canals have cost at a mean 240,000 francs the kilometre ($71,760 the mile); at this rate, there would be needed for interest, maintenance, and reimbursement, at least 14,000 francs per kilometre ($4186 per mile). Now, in presence of railroads, the tolls cannot exceed 0·02 franc per ton (0·598 ct.) We should then count upon a traffic of 700,000 tons, which few lines attain, even after many years.

All expenses are thus productive, and some beyond all previous hope.

Some examples, selected from many northern lines, give evidence of the great gain attendant upon such works.

The author here gives a table in which the cost of improvements upon the

Escaut and St. Quentin canal are set at	.	6,000,000 fr.
Those upon the lower Scarpe and Deule at	.	2,650,000 "
Total,		8,650,000 "

It appears that the total annual gain of 1847 over the year 1833, or that resulting from the execution of the works, rose to 8,939,768 fr., and thus exceeded the amount of capital expended, the interest being over 100 per cent.

All the useful expenditures for the improvement of canals will not of course be so productive. But we may affirm with certainty that upon the great arteries whose circulation varies from 300 to 1200 thousand tons, all the works which may facilitate the passage of boats, will return with usury to the public the sacrifices made for their execution.

Results of high importance may often be obtained in operating upon lines with small traffic. Thus in the improvement of the upper Lys and the Lawe rivers, but little frequented, its influence was felt at the same time upon the competing canal from Aire to the Bassée, and so there will be a positive reduction in the cost of transportation of heavy masses, now exceeding 400,000 tons, which will undoubtedly be increased, from the workings of the oil mines recently discovered in Pas-de-Calais.

The Northern navigation has for forty years been the object of numerous works, and still we may without undervaluing the improvements effected affirm, that there remains yet much to be done. Now if this is true for this part of France, where the navigable lines have reached a great relative perfection, why should we not expect elsewhere, useful conquests to be made, and important economies to be realized?

We should place in the first rank, the improvement of rivers which unite or prolong the canals; with these relatively little costly works we may increase the value of extended lines, which in good condition upon the greater part of their development, are often paralyzed by defect of anchorage and different obstacles upon the rivers from which they derive their flow. Other improvements may undoubtedly be proposed; but their research is foreign to our purpose: we only desire to show what advances can be made in this direction. The studies which the government have prescribed to determine the expenses called for in the improvement of navigable routes bear witness of its deep solicitude for them, and of its confidence in their success.

15. It remains to examine the special conditions of the working of navigable routes, and to search out the economies of which they are susceptible.

The expenses of transportation comprise:

1st. The general expenses independent of the distance.

2d. The special expenses applicable to the line.

The general expenses may be valued as a mean at 1 fr. per ton for oil (including the customs), and are distributed as follows:

Insurance, . . .	0·100 fr.
Freight commissions, . .	0·075 "
Charge paid by boatman, . .	0·090 "
Customs, . . .	0·035 "
20 days wharfage, . . .	0·700 "
	1·000 fr.

An increase in the draft of boats, a better organization of *stoppages*, and the hastening the discharge, concur to reduce the expenses. The first measure will admit of an increase from 200 to 270 tons per boat; the second will yield 330 days of navigation yearly, instead of 275; the third will reduce the time of stopping from 20 to 15 days.

Thus the part of the general expense, answering to the days of stoppage, 0.70 fr., may be progressively reduced to

$$0{\cdot}70\ \frac{275 \times 200 \times 15}{330 \times 270 \times 20} = 0{\cdot}32 \text{ fr.}$$

Which gives an economy of 0·38 fr. and reduces the cost of general expense applicable to these transportations to 0·62 fr.

When we compare the necessary forces to draw the same useful load upon canals and railroads, in their ordinary working condition, we find a great difference in favor of navigable routes.

Thus for hauling a boat 5 m. (16·4 ft.) wide, drawing 1·3 m. (4·26 ft.) of water, and carrying 225 tons of useful load with a velocity of 2 kilometres (1·24 miles) per hour (1·8 ft. per second) upon a canal with 18 square metres (193¾ sq. ft.) of section, there is required an effort of 72·05 kil. (159 lbs.)*

Upon a railroad, the gross weight corresponding to the same load of 225 tons will be 375 tons (locomotive and tender included), and the corresponding effort at the rate of 4 kilogrammes (8·82 lbs.) per ton will be 1500 kilogrammes (3308 lbs.)

Here undoubtedly lays the true power of the navigable route; but while appreciating its superiority in this respect, we must not exaggerate its importance, nor disregard the conditions. If we look for greater speed upon canals, the effort necessary for this increases proportionally to the square of the velocity,† and to attain the speed giv-

* The formula, given by D'Aubuisson des Voisins, in his Traite d'hydraulique:

$$E = 140\ k.\ \frac{s^2\ v^2}{c + 25} \text{ gives in this case } E = 140\ k.\ \frac{(7{\cdot}50 \times 0{\cdot}55)^2}{18 + 15}$$

The same equations in units of feet and lbs. is

$$E = 2{\cdot}664\ \frac{s^2\ v^2}{c + 2s}$$

See page 297 Bennett's translation.

† We leave out of the question fast boats, necessarily very light, for which the resistance follows another law.

en to the transportation of bulky merchandise upon railroads (20 kilometres or 12·42 miles per hour) requires an effort one hundred times greater than the above calculated, or 7205 kilogrammes, and as upon the railroad the effort for this velocity is but 1500 kilogrammes, the proportion between the two routes is completely reversed. The great economy of transportation by the canal supposes implicitly a moderate speed; but in diminishing the velocity to reduce the expense of haulage, we increase the expenses in boating, material, and equipage, which are used a greater length of time; it follows that there must exist in each particular case, a velocity corresponding with the minimum net cost.

(To be Continued.)

On the Results of Trials of Varieties of Iron Permanent Way. By Mr. F. Fox, M. Inst. C. E.

From Newton's London Journal, March, 1861.

The author stated, that he did not wish to be thought an advocate for the superiority of either of the systems tried over other plans, or of iron over timber for permanent way, under any and all circumstances; his object being merely to record results of actual trials, and the conclusions to which they led.

In 1853, an experimental length of a quarter of a mile (double line) of iron way, on the principle of Mr. I. J. Macdonnell (M. Inst. C. E.,) was laid on the Bristol and Exeter Railway. It consisted of a continuous rolled iron rail bearer, weighing, on an average, 83½ lbs. per lineal yard, and 11 inches in width. The bearers were united by joint or saddle plates 30 inches in length, weighing 50½ lbs. each. The bearers had a rise in the centre of $\frac{9}{16}$ths of an inch, and a rib or tongue was rolled on the upper side, which fitted approximately into the hollow of the bridge rail. The rails originally laid weighed only 53¾ lbs. per yard. Between the rail and the bearer, a thin packing of pine wood was placed, the grain being in the direction of the length of the rail. The rails, the bearers, and the joint plates, were bolted together, the distances between the intermediate bolts being so arranged as to admit of a rail being readily turned by unscrewing the nuts, or of a new rail being put in, without "opening out" the ballast. Transoms, or cross ties of angle iron were placed at average intervals of 12 feet between the two rails, and 24 feet between the two lines. This system differed from the Barlow way, in having the rail or wearing surface separate and easily removable from the bearing surface; but, on the other hand, it considerably exceeded the Barlow rail in weight. After a wear of more than seven years, this length of iron way was in good condition, and bid fair to continue so for some time to come. About one-third of the rails proved defective within the first two years and had been replaced by rails weighing 60 lbs. to the yard. The ballast, which was very indifferent, being a loamy gravel, had been well drained, and thicker packing, laid with the grain transversely to the direction

of the rail, had been introduced. The bearers and joint plates, transoms, and rails, were supplied at £7 per ton delivered, and the cost per single mile of this arrangement, exclusive of the cost of matching and laying, was £1936. The cost of a single mile of the longitudinal timber way, at the same period, taking the rails at the same weight and price, was estimated at £1850. It should be mentioned that iron was then low in price, whilst timber was high. Owing to the undue lightness of the rail, both of these calculations were below the cost of a well constructed permanent way.

As this experiment appeared on the whole to have been successful, it was determined to extend the trial, by laying one mile of double line, on this system, at a further distance from a station, so that all trains should pass over it at full speed. Some modifications were, however, made. The width of the bearer was increased to 12 inches, and its thickness was reduced to $\frac{9}{16}$ths of an inch, so that its weight was 75 lbs. per lineal yard. At the same time the curvature was slightly increased. The pine packing (creosoted) was thicker, and at the rail joints pieces of hard wood, laid with grain lengthwise, were substituted. The rails weighed 68 lbs. per yard. The contract for the bearers, joint plates, and transoms was taken at £9 10*s.* per ton, —the cost of rails being £9 8*s.* 8*d.* per ton. This length was laid in July, 1857, where the line had not long before been re-ballasted with hard clinker ballast. The cost of a single mile, exclusive of laying, amounted to £2511. One mile of timber way, laid with the same section of rail at the same time, cost about £2254.

As these trials appeared to give a reasonable expectation of the greater durability and diminished cost of maintenance of the iron way, the author felt justified in recommending a further trial, on a more extended scale, and on different districts of the railway. As the rolling and straightening of the curved section of bearer was alleged to be difficult, it was decided to adopt a flat section. The bearing surface was increased to 13 inches, the centre rib was rolled ½ an inch deeper, and the weight was thus brought up to 84 lbs. per yard. Rail joint plates of a similar section to the bearer joint plates were bolted underneath the bearer at every rail joint. Although this addition had been found advantageous, the way was still weaker at the rail joints than at any other part. Additional intermediate bolts were used, so that the upper and lower sections of the way were held together as a girder. The contract for the bearers, joints, and transoms, was taken at £9 12*s.* per ton, and the rails, being £8 13*s.* 1*d.* per ton, the cost per single mile was £2571.

In order to test the comparative strength of the different sections of bearer, of rail and bearer combined as laid, and of the rail and bearer joints with and without joint plates, a series of experiments were made, the results of which were given in tabular form. The distance between the points of support was 5 feet. Of the three sections of bearer only, that of 1853 (the first) showed the least, and the flat section of 1859 the greatest, deflection, under a load of about 5 tons; but in each case the ultimate strength did not exceed 7 tons. Of the three

sections of iron way complete, that of 1853 was the weakest, and the curved section of 1857, with a rail weighing 68 lbs. per yard, rather the strongest. The ultimate strength was reached under loads varying from 19 to 21 tons. An experiment with the flat bearer showed, as was expected, the increased stiffness gained by placing the centre rib downwards, thus practically deepening the girder. The ultimate strength of the timber way was ascertained to be 28½ tons, or 50 per cent. higher than the iron way. It was, therefore, determined still further to increase the section of the iron bearer. In this case the width of the bearer was 12 inches, and it was stiffened by a web underneath, 3 inches deep and ¾ of an inch thick (a plan which was claimed by Mr. W. Bridges Adams). The weight was reduced to 76 lbs. per yard, and the contract for this section was taken at £9 per ton. To stiffen the rail joints (which had no plates underneath), and to secure the ends of the rails, an iron plate, having a tongue rolled on it, was used. This section of way has been laid too short a time to warrant any decided expression of opinion of it, as compared with the other sections; but as a length of between 4 and 5 single miles was under trial, it would soon be seen if it possessed any advantages. It was perceptibly stiffer to travel over, and the middle web gave it a firmer hold in the ballast than either of the other sections. The cost of a single mile was £2385. This section was the fourth modification of rolled iron bearer under trial, the entire length being 14¼ single miles.

The partial failure of the Macdonnell way on the Bridport railway was then referred to; and it was asserted that it arose from the rails and bearers being too weak, and from a disregard of those appliances which the character of the gradients, curves, ballast, and subsoil rendered more than ordinarily necessary.

In May, 1858, a trial length, of a single half mile, of the cast iron sleeper way of Mr. De Bergue, was laid in immediate continuation of the Macdonnell way, and on the same kind of clinker ballast. Whilst still preferring a continuous rolled iron to any cast iron way, the author felt bound to state that not a single sleeper had been broken, the nuts of the bolts did not work loose, the rails wore very well, and with the exception of a little depression at the fished rail joints, the line kept as good a "top" as could be desired, and was as easily maintained, but it was more rigid. The cost of this arrangement per single mile was £2103, or £300 per mile less than the Macdonnell way of the same period

The merits and defects of the continuous rolled iron permanent way were thus stated. The defects, or supposed defects, appeared to be:—1. The great cost, at present prices, almost precluding its adoption on a railway of limited capital. 2. The difficulty of getting the bearers rolled. 3. The possible increased wear of the rails. 4. The greater "wash" of all but very good ballast, inseparable from all iron ways, resting on or near the surface. And, 5. The difficulty of laying on sharp curves, and of keeping in place when laid. Its presumed merits were:—1. Greater economy in the long run, owing to increased dura-

bility. It was estimated that the cost of renewal of the longitudinal timber way was £45, and of the iron way only £21, per single mile per annum, or less than half, without reckoning the considerable item of labor in the replacement of the timbers. 2. Saving in maintenance, and facility for packing, owing to no "opening out" being required. 3. The safety of the iron way, especially as contrasted with a timber way which had been long laid. 4. The facility of exchanging worn rails. 5. The preservation of correct gauge. 6. The lowness of the crown of the rail above the bearing surface. 7. Saving in the depth of ballast in the case of a new line. And, 8. The equableness of the motion, rendering it probable that less injury would be sustained by the rolling stock.—*Proc. Inst. Civ. Eng.*

MECHANICS, PHYSICS, AND CHEMISTRY.

Translated for the Journal of the Franklin Institute.

Action of Light upon a Mixture of Perchloride of Iron and Tartaric Acid: Application to Photographic Printing. Note of M. POITEVIN.—*Academie des Sciences* (Paris), 21 January, 1861.

A long time since I observed that the salts of the peroxide of iron are reduced to the salts of the protoxide by light, in presence of certain organic substances, such as alcohol, ether, &c. As I was seeking to apply this property to photographic printing, I looked for reducing substances which were not volatile. The salts of the sesquioxide of uranium, which are themselves reduced by light, in presence of organic bodies (such as paper), react upon the per-salts of iron, by means of the protoxide of uranium which is at first formed. Acetate of ammonia, alloxanthine, glycerine, and especially tartaric acid, also furnished very distinct reactions which could be used in photography. Although this reduction is common to all the per-salts of iron, and even to the peroxide, which I also experimented upon, I confine myself to the use of a mixture of the perchloride of iron and tartaric acid, and shall speak of these substances only.

The partial formation of sesquigallate of iron on paper or other substances, for producing photographic pictures on them, is based upon the reduction of the sesquichloride of iron to protochloride, which takes place only at the points submitted to the action of the light.

The application of powdered charcoal or other coloring matters, and vitrifiable bodies, depend on another property, which, I believe, I was the first to observe: it is, that the perchloride of iron and tartaric acid dissolved in certain proportions and applied to a given surface, dried either spontaneously or artificially in the dark, give a uniform coat of a non-crystalline compound which is not hygroscopic, and remains thus so long as it is kept from the light; but which becomes deliquescent in the sun or in diffused light. I shewed, in the parts influenced by the light, the presence of the protochloride of iron which is deliquescent, and of a body of acid reaction which is very greedy of water, and which must have been formed by the reaction of chlorine upon tartaric acid; it is particularly this latter product which plays the most im-

portant part in the application of dry powders on photogenic surfaces, for when I reduce the dose of tartaric acid, there is not enough formed to fix the powder.

The following are the ways in which I operate:

1st. *For Printing by Gallate of Iron (common ink).*—I make a solution containing 10 grammes of perchloride of iron to 100 grammes of water; I add 3 grammes of tartaric acid, filter, and preserve from the light. To prepare the papers I pour this mixture into a dish, and apply successively each sheet, to its surface, taking care that no air-bubbles intervene; I withdraw it at once, and suspend it, in order to let it dry, in the dark; or after letting it drip, I dry it by the fire. The paper thus prepared may be kept for a long time; it is of a deep yellow color. To produce the picture, put it into the press under a photographic negative, or under the picture to be copied, and leave it exposed to the lights which penetrate the lights of the screen, until the yellow color has disappeared, and the picture in dark yellow appears on the whole ground of the paper; plunge rapidly the sheet into distilled water, then into a saturated solution of gallic acid, or an infusion of nut-galls, or into a mixture of gallic and pyrogallic acids, according to the tone of the black which you desire to get. In either case the organic acid forms ink only in the parts where the perchloride of iron has not been decomposed, and is without action on the protochloride which covers the parts on which the light has acted. To fix this picture it is sufficient to wash it with distilled or rain water.

2d. *Printing by Carbon and Powdered Colors; Photographic Stained-glass; Painting on Porcelain and Enamel.*—While practising the above mode of printing, I had remarked that the paper, after the impression had been made, had become very permeable to water in the insolated parts. I made use of this property in forming images with powders of various kinds. It sufficed for this purpose, to moisten the reverse of the sheet with gum water; this water passed through the paper and held the powder which was applied with a brush. Afterwards, by replacing the paper by surfaces of ground-glass, covering them with the above-mentioned mixture and drying them, I remarked that after their exposure to light, covered with a negative, the parts influenced, spontaneously covered themselves with moisture, and that the preparation from its original dryness had become deliquescent in those parts only; this led me to another mode of impression, which I will describe.

I make two solutions: one containing 16 grammes of perchloride of iron, the other 8 grammes of tartaric acid to 100 grammes of water; equal volumes of these two liquids are mixed in proportion as they are used. Upon surfaces of ground-glass, smoothed and perfectly cleaned, or on surfaces of polished glass previously covered with collodion or other basis, I pour the above mixture, spread it, and drip off the excess; I then allow these plates, laid either edgewise or horizontally, to dry either spontaneously or before the fire, according to the thickness of the coat which we desire to obtain. The plate when dried may be kept for a long time before using it. The printing is done through

a negative; it may require five or ten minutes in the sun, according to the season and the depth of the negative. In coming out of the press, the picture is scarcely visible on the plate, but becomes so very soon, by means of the coat of dampness which forms only on the parts impressed. This damp coating allows me to cause the adhesion of the powders wherever it exists, and the picture appears gradually under a brush charged with dry colors. The proof may be kept in this state; it is unchangeable, but it will be better to remove, first by acidified alcohol and afterwards by water, the parts of the impression not modified by light (they are but slightly soluble in pure water), then dry the plate and varnish the picture. A transparent picture is thus obtained. If a painting on glass is desired, mineral oxides or powdered enamels are employed for the powdering, and the sheets of glass are submitted in a muffle to a temperature sufficient to liquefy the flux or enamel; the same thing may be done on porcelain or enamelled surfaces.

When an impression on paper only is wanted, I employ powders of carbon, or other colors insoluble in water; I pour over the surface which has the picture, a solution of normal collodion, wash with acidulated water to remove the excess of the preparation and destroy the adherence of the collodion to the plate, and remove that coating by means of gelatine-paper. Not a trace of the picture remains on the glass. I gum or varnish the picture to secure it, and paste it upon card-board. I have also observed that this preparation by perchloride of iron and tartaric acid had the property of retaining fatty matters only upon the parts which have not received the light, and I have thus obtained a new means of printing by fat-inks and chemical engraving. —*Comptes Rendus.*

The Patent Painted and Gilded Leather Cloth.

From the London Builder, No. 933.

The majority of our readers have, doubtless, met with the patent leather cloth used to cover seats and otherwise, and many have seen it in its painted and gilded shape as manufactured by the Leather Cloth Company; nevertheless, they would probably be surprised, as we certainly were ourselves, to find a huge warehouse in Cannon-street West, filled with rolls of it. In France it has long been extensively supplied by this company, but here as yet it has only been occasionally used. In the new Westminster Palace Hotel, for example, it is hung in the smoking-room; and, at the Royal Hotel, Bridge-street, Blackfriars, in the billiard and reading-rooms. Many of the designs already produced are very elegant; and it may be made to present all the elegance of gilded leather, the *cuir doré* and the *cuir argenté* of the Middle Ages, while its cost is but trifling as compared with those hangings with which, as we know, in the sixteenth and seventeenth centuries all the houses of the Venetian nobles and gentry were hung. In England, too, it was greatly used, and examples may still be found in old houses. The cost of the painted and gilded leather cloth may

be called about 2*s*. 6*d*. a yard square, being enamelled by a patent process, which preserves the original beauty of the gilding, and allows it to be washed without injury. It is very durable, and it could be hung on new walls, on which it would not be safe to paint or put paper.

This company, who have manufactories also in France and Belgium, have large works at West Ham, where they employ about 150 men. Looking over their warehouse, we saw large quantities also of their vulcanized india rubber belting, which, as being more durable, appears to be fast superseding the leather belting.

For the Journal of the Franklin Institute.

Strength of Cast Iron and Wrought Iron Pillars: A series of Tables deduced from several of Mr. Eaton Hodgkinson's Formulæ, showing the Breaking Weight and Safe Weight of Cast Iron and Wrought Iron Uniform Cylindrical Pillars. By Wm. Bryson, Civ. Eng.

D = diameter or side of the square of solid pillar in inches.
D = external diameter of hollow pillar in inches.
d = internal diameter of hollow pillar in inches.
L = length or height of the pillar in feet.
W = breaking weight in tons.

Hollow Uniform Cylindrical Pillars of Cast Iron with Both Ends Rounded.

Length in Feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	$W = 13 \frac{D^{3.6} - d^{3.6}}{L^{1.7}}$ Breaking weight in tons.	$W = 13 \frac{D^{3.76} - d^{3.76}}{L^{1.7}}$ Breaking weight in tons.
8	32	3	2	15·18	18·54
9	36	3	2	12·43	15·09
10	40	3	2	10·39	12·64
11	44	3	2	8·83	10·73
12	48	3	2	7·62	9·25
13	52	3	2	6·65	8·08
14	56	3	2	5·86	7·12
15	60	3	2	5·21	6·33
16	64	3	2	4·67	5·67
17	68	3	2	4·21	5·12
18	72	3	2	3·82	4·64
19	76	3	2	3·49	4·23
20	80	3	2	3·19	3·88
21	84	3	2	2·94	3·57
22	88	3	2	2·71	3·30
23	92	3	2	2·52	3·06
24	96	3	2	2·34	2·84
25	100	3	2	2 18	2·66

Solid Uniform Cylindrical Pillars of Cast Iron with Both Ends Rounded, and with Both Ends Flat.

Length in Feet.	Number of diameters contained in the length or height.	Diameter in inches.	Solid uniform cylindrical pillars of cast iron with both ends rounded. $w = 14{\cdot}9 \frac{D^{3{\cdot}76}}{L^{1{\cdot}7}}$ Breaking weight in tons.	Solid uniform cylindrical pillars of cast iron with both ends flat. $w = 44{\cdot}16 \frac{D^{3{\cdot}55}}{L^{1{\cdot}7}}$ Breaking weight in tons.
8	32	3	27·03	63 60
9	36	3	22·12	52 06
10	40	3	18·49	43·52
11	44	3	15·73	37·01
12	48	3	13 56	31·92
13	52	3	11·84	27·86
14	56	3	10 43	24·56
15	60	3	9·28	21·84
16	64	3	8 31	19 57
17	68	3	7 50	17 65
18	72	3	6·81	16·02
19	76	3	6·21	14·61
20	80	3	5·69	13·39
21	84	3	5·24	12·33
22	88	3	4·84	11·39
23	92	3	4 48	10·56
24	96	3	4·17	9·82
25	100	3	3·89	9·16

Solid Uniform Cylindrical Pillars of Wrought Iron with Both Ends Rounded, and with Both Ends Flat.

Length in Feet.	Number of diameters contained in the length or height.	Diameter in inches.	With both ends rounded. $w = 42{\cdot}8 \frac{D^{3{\cdot}76}}{L^2}$ Breaking weight in tons.	With both ends flat. $w = 133{\cdot}75 \frac{D^{3{\cdot}55}}{L^2}$ Breaking weight in tons.
8	32	3	41·60	103·23
9	36	3	32·87	81·44
10	40	3	26·63	66·07
11	44	3	22·00	54·60
12	48	3	18·49	45·88
13	52	3	15·75	39·09
14	56	3	13·58	33·71
15	60	3	11·81	29·36
16	64	3	10·40	25·80
17	68	3	9·21	22·86
18	72	3	8·21	20·39
19	76	3	7·37	18·30
20	80	3	6·65	16·51
21	84	3	6·03	14·98
22	88	3	5·50	13·65
23	92	3	5·03	12 49
24	96	3	4·62	11·47
25	100	3	4·26	10·57

Hollow Uniform Cylindrical Pillars of Cast Iron, with Both Ends Flat.

Length in Feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	$w = 44{\cdot}34 \frac{D^{3{\cdot}55} - d^{3{\cdot}55}}{L^{1{\cdot}7}}$ Breaking weight in tons.	$w = 42{\cdot}347 \frac{D^{3{\cdot}5} - d^{3{\cdot}5}}{L^{1{\cdot}63}}$ Breaking weight in tons.
8	32	3	2	48·72	50·49
9	36	3	2	39·88	41·79
10	40	3	2	33·34	35·19
11	44	3	2	28·35	30·13
12	48	3	2	24·45	26·14
13	52	3	2	21·34	22·95
14	56	3	2	18·81	20·33
15	60	3	2	16·73	18·17
16	64	3	2	14·99	16·36
17	68	3	2	13·49	14·81
18	72	3	2	12·27	13·50
19	76	3	2	11·20	12·36
20	80	3	2	10·26	11·37
21	84	3	2	9·44	10·50
22	88	3	2	8·72	9·73
23	92	3	2	8·09	9·04
24	96	3	2	7·52	8·44
25	100	3	2	7·01	7·90

Hollow Uniform Cylindrical Pillars of Cast Iron, with Both Ends Flat.

Length in Feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	$w = 46{\cdot}65 \frac{D^{3{\cdot}55} - d^{3{\cdot}55}}{L^{1{\cdot}7}}$ Breaking weight in tons.	$w = 44{\cdot}3 \frac{D^{3{\cdot}6} - d^{3{\cdot}6}}{L^{1{\cdot}7}}$ Breaking weight in tons.
8	32	3	2	51·26	51·74
9	36	3	2	41·93	42·36
10	40	3	2	35·08	35·42
11	44	3	2	29·83	30·11
12	48	3	2	25·73	25·97
13	52	3	2	22·44	22·67
14	56	3	2	19·79	19·98
15	60	3	2	17·60	17·77
16	64	3	2	15·77	15·93
17	68	3	2	14·19	14·36
18	72	3	2	12·91	13·03
19	76	3	2	11·78	11·89
20	80	3	2	10·79	10·89
21	84	3	2	9·93	10·02
22	88	3	2	9·18	9·26
23	92	3	2	8·51	8·59
24	96	3	2	7·91	7·99
25	100	3	2	7·38	7·46

Hollow Uniform Cylindrical Pillars of Cast Iron, with Both Ends Flat.

Length in Feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	$w = 46{\cdot}65 \frac{D^{3{\cdot}55} - d^{3{\cdot}55}}{L^{1{\cdot}7}}$ Breaking weight in tons.	Safe weight in tons.	Assumed breaking weight if irregularly set in tons.	Assumed safe weight if irregularly set in tons.
8	32	3	1½	61·43	15 35	20·47	5 11
9	36	3	1½	50 28	12·57	16·76	4·19
10	40	3	1½	42·14	10 53	14·04	3·51
11	44	3	1½	35·76	8·94	11·92	2·98
12	48	3	1½	30 84	7 71	10·28	2 57
13	52	3	1½	26·92	6·73	8·97	2 24
14	56	3	1½	23·73	5·93	7·91	1 97
15	60	3	1½	21·10	5·27	7·03	1·75
16	64	3	1½	18·91	4·72	6 30	1·57
17	68	3	1½	17 05	4·26	5 68	1·42
18	72	3	1½	15 48	3 87	5·16	1·29
19	76	3	1½	14·12	3·53	4·70	1·17
20	80	3	1½	12·94	3 23	4 31	1·07
21	84	3	1½	11·90	2·97	3 96	0·99
22	88	3	1½	11·00	2·75	3·66	0·91
23	92	3	1½	10·20	2·55	3·40	0·85
24	96	3	1½	9·49	2·37	3·16	0 79
25	100	3	1½	8·85	2 21	2·95	0·73
26	104	3	1½	8 28	2·07	2·76	0·69
27	108	3	1½	7·76	1·94	2·58	0 64
28	112	3	1½	7·30	1·82	2·43	0 60
29	116	3	1½	6·88	1·72	2·29	0·57
30	120	3	1½	6·49	1·62	2·16	0·54

Hollow Uniform Cylindrical Pillars of Cast Iron, with Both Ends Rounded.

Length in Feet.	Number of diams. contained in the length or height.	External diameter in inches.	Internal diameter in inches.	$w = 13 \frac{D^{3{\cdot}6} - d^{3{\cdot}6}}{L^{1{\cdot}7}}$ Breaking weight in tons.	Safe weight in tons.
8	16	6	4	184·08	46·02
10	20	6	4	125·97	31·49
12	24	6	4	92·43	23·10
14	28	6	4	71·11	17·77
10	17·143	7	5	200·72	50·18
12	20·571	7	5	147·16	36·79
14	24	7	5	113·23	28·30
16	27·428	7	5	78·52	19·63
12	18	8	6	218·73	54·68
14	21	8	6	168·35	42·08
16	24	8	6	134·16	33·54
18	27	8	6	109·72	27·43
14	16·8	10	8	321·75	80·43
16	19·2	10	8	256·36	64·09
18	21·6	10	8	209·82	52·45
20	24	10	8	175·37	43·84
16	16	12	10	430·82	107·70
18	18	12	10	352·69	88·17
20	20	12	10	294·84	73·71
22	22	12	10	250·64	62·66

Hollow Uniform Cylindrical Pillars of Cast Iron, with Both Ends Flat.

Length in Feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	$w = 44{\cdot}34 \frac{D^{3{\cdot}55} - d^{3{\cdot}55}}{L^{1{\cdot}7}}$ Breaking weight in tons.	Safe weight in tons.
15	45	4	2	55·72	13·93
15	36	5	3	112·58	28·14
15	30	6	4	196·05	49·01
				$w = 42{\cdot}317 \frac{D^{3{\cdot}5} - d^{3{\cdot}5}}{L^{1{\cdot}63}}$	
15	45	4	2	59·81	14·95
15	36	5	3	119·30	29·82
15	30	6	4	205·59	51·39
				$w = 46{\cdot}65 \frac{D^{3{\cdot}55} - d^{3{\cdot}55}}{L^{1{\cdot}7}}$	
15	45	4	2	58·62	14·65
15	36	5	3	118·44	29·61
15	30	6	4	206·27	51·56
				$w = 44{\cdot}3 \frac{D^{3{\cdot}6} - d^{3{\cdot}6}}{L^{1{\cdot}7}}$	
15	45	4	2	59·85	14·96
15	36	5	3	122·50	30·62
15	30	6	4	215·56	53·89

Solid Uniform Cylindrical Pillars of Cast Iron, with Both Ends Flat.

Length in Feet.	Number of diameters contained in the length or height.	Diameter in inches.	$w = 44{\cdot}16 \frac{D^{3{\cdot}55}}{L^{1{\cdot}7}}$ Breaking weight in tons.	Safe weight in tons.
10	30	4	120·8	30·20
12½	30	5	182·6	45·65
15	30	6	255·9	63·97
17½	35	6	197·0	49·25
20	40	6	156·9	39·22

Solid Uniform Cylindrical Pillars of Wrought Iron, with Both Ends Flat.

Length in Feet.	Number of diameters contained in the length or height.	Diameter in inches.	$w = 133{\cdot}75 \frac{D^{3{\cdot}55}}{L^2}$ Breaking weight in tons.	Safe weight in tons.
10	30	4	183·5	45·87
12½	30	5	259·4	64·85
15	30	6	344·1	86·02
17½	35	6	252·8	63·20
20	40	6	193·5	48·37

NOTE.—In the above tables, the breaking weight is not critically correct for those pillars with *flat ends*, whose height is only 30 diameters.

In my calculations, I find that the breaking weight of pillars, as deduced from the formulæ for long flexible pillars with *flat ends*, is not correct, unless the height of the pillar is nearly 31 times its diameter.

Hollow Cylindrical Pillars of Cast Iron, with Both Ends Flat.

Length in Feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	$Y = \frac{b\,c}{b + \frac{3}{4}c}$ Breaking weight in tons.	Safe weight in tons.
8	24	4	3	100·07	25·01
8	19 1-5	5	4	160·94	40·23
8	16	6	5	229·22	57·30
8	13 5-7	7	5½	426·70	106·67
8	12	8	6½	539·67	134·91
8	10 2-3	9	7½	656·30	164·07
8	9 3-5	10	8½	774·87	193·71
8	8 8-11	11	9	1153·46	288·36
8	8	12	10	1313·65	328·41
8	7 5-13	13	11	1475·01	368·75
8	6 6-7	14	12	1635·95	408·98
8	6 2-5	15	12½	2197·02	549·25
8	6	16	13½	2398·52	599·63
8	5 11-17	17	14½	2596·32	649·08
8	5 1-3	18	15½	2800·97	700·24

NOTE.—The value of Y in the above formula is compounded of two quantities: *b*, the strength as obtained from one of the formulæ for long flexible pillars; and *c*, the crushing force.

The following tables show the breaking weight of uniform hollow cylindrical pillars of cast iron, deduced from several formulæ, and for different qualities of cast iron:—

Length or height of the pillar, 8 feet. External diameter, 18 inches. Internal diameter, 15½ inches.

2800·98 tons.	2103·10 tons.
2800·94 "	2157·72 "
2781·93 "	2146·40 "
2746·46 "	

Length or height of the pillar, 10 feet. External diameter, 18 inches. Internal diameter, 15½ inches.

2641·49 tons.	2114·46 tons.
2641·15 "	2061·84 "
2616·51 "	2046·79 "

(To be Continued.)

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New Investigations as to the Friction of Cars Sliding on the Rails of a Railroad. By M. H. BOCHET. *Acad. des Sciences de Paris*, 17 December, 1860.

In a preceding memoir presented to the Academy on the 26th April, 1858, I had already begun the question which I have since resumed in order to study it in a more extensive way; it is the results of this last investigation, altogether of an experimental nature, which I now communicate. Doubtless, I have not yet been able to grasp the problem of friction under all its possible circumstances; but I have attacked it in a great number of various cases, to wit: in the case of the sliding at all possible velocities from 0 to 25 metres per second, of iron with different degrees of polish, different woods, wet or dry, common or resinous, even of leather and gutta-percha, rubbing on surfaces of various sizes; always, it is true, by cars sliding over the rails of railroads, but on rails sometimes dry, sometimes wet, sometimes simply damp, sometimes even greased.

I have also been able to study, under the different circumstances indicated above, the question of the friction at starting.

In the first part of my memoir I describe in detail the process of experimental investigation which I followed, the rubbing apparatus which I employed, the dynamometer which I used to measure the resistance, the manner in which I was able to measure the velocity at each instant, and the precautions which I took to avoid the causes of error in the true values of the friction; I describe the mode adopted for the graphic representation of my experimental results, the method followed in each experiment, the various cases of friction examined, and the special conditions of my experiments upon the friction at starting.

In the second part, I present the results established by my experiments; these results are,

1. Want of constancy of the friction under the same circumstances

as far as they could be appreciated and defined in practice; so that the friction, even under circumstances practically identical, cannot be represented by a single curve, but only by a zone bounded by two curves, with a curve of the mean or more common friction under determinate circumstances.

2. The diminution of the friction in proportion as the velocity increases (all other things being the same) in all the cases which were examined.

3. Variation of the friction with the extent of the rubbing surfaces, all other things being equal, or otherwise expressing it, under the specific pressure. A variation which is insensible, so long as this specific pressure remains small, especially if, at the same time, the velocity is small; but sensible, if the velocity of the sliding is great, and especially when the specific pressure passes from large to small values. Whence it results, that the accepted law of the proportionality of the friction to the pressure, which is sensibly true under the ordinary circumstances of practice, cannot be considered as absolutely and generally exact. Yet the experiments related in my memoir, although sufficient to establish this fact, are not yet sufficient to allow us to deduce with precision the true law of the variation of the friction with the pressure.

4. A considerable variation in the friction of wood, according as the rails are dry, wet, or greasy; on the contrary, the complete insignificance of the state of dryness or moisture of the rails on the friction of iron; unimportance even of the state of greasiness, at the commencement of the sliding (before the production of an especial polish), unless the rubbing surface is relatively very small (as that of locked wheels) and the specific pressure consequently very great, in which case the friction of iron was very much diminished by a fatty lubric even at the beginning of the sliding.

5. A considerable influence of the condition as to polish, upon the friction; especially on that of iron; much less on that of wood.

6. The friction of wood much greater than that of iron, when dry.

7. The slight influence of the nature of the wood upon its friction; insensible when there is a lubric (except when the wood is resinous, and the lubric only water, in which case the friction is greater than in others); the influence of the nature of the wood only becomes sensible, though still slight, when the surfaces are dry; then tender woods produce a slightly greater friction than hard woods.

8. There was no especial friction at starting, except in the cases of wood and leather, upon wet or greasy rails; in all other cases (wood and leather upon dry rails, gutta-percha on rails dry or wet, iron on rails dry, wet, or greasy) the friction at starting was exactly the same at extremely small velocities (but of course greater than at notable velocities); on the contrary, for wood and leather on wet or greasy rails the friction at starting was, in the mean, double that corresponding to an extremely low velocity.

In a third part of my memoir, I have endeavored to give the explanation of the phenomena, and the laws of the friction which experiment

revealed. I have shown that we ought to admit three essential and general causes of friction, to wit: molecular attraction, the roughness of the surfaces, and the particular tearing which is produced in consequence of this, during the sliding; that the action of these three causes appears to explain the phenomena which friction presents. Not that I have been able to explain them all in this way, especially in all their details; but I believe that I have given a satisfactory and admissible explanation, in a general way only, of the most prominent phenomena, such as: 1, of the diminution of the friction as the velocity increases; 2, of the zones of friction; 3, of the influence of the nature of the material; 4, of the influence of the polish of the surfaces; 5, of the non-existence in general of an especial friction at starting. Some of the peculiarities which I have not explained, moreover, do not at all invalidate the general considerations which I have presented and which explain other facts.

In the fourth and last part, I show that all the values, very numerous, which I have obtained for the friction under the different circumstances, may be represented with sufficient approximation by the following formula, which is presented as being the simplest which can be adopted, so as to satisfy properly the condition of exactness.

$$f = p\left(\frac{k-y}{1+av}+y\right);$$

in which f is the value of the friction; p represents the total pressure under which the sliding took place; k and y are two co-efficients variable with the circumstances, the value of k being always greater than y; a is a third co-efficient, perhaps slightly variable, but if so, by a law which is still entirely unknown and not even suspected; but perhaps also constant, and at all events which may be assumed constant with a sufficient approximation in practice, and then it is equal to 0·3 when the velocity is expressed in metres per second.

As to the co-efficients k and y, they vary separately with the substances which slide upon each other, with the degree of polish of their surfaces, the presence or absence of a lubric between these surfaces, and the nature of this lubric, and also with the specific pressure under which the sliding takes place. We can only give tables of the numerical values of k and y for determinate conditions and states. I have given a considerable number, deduced from positive experiments. To give an idea of the principal circumstances, I may say that the greatest frictions being those of wood, and especially soft wood, leather, and gutta-percha, on dry rails, without lubric, k sometimes rose to 0·70 and was never below 0·40, and most frequently was 0·60 for tender woods and 0·55 for hard woods. The friction of iron was always less; it is true, that in exceptional cases when the iron was of very coarse and wrinkled surface, k sometimes rose to 0·60, but habitually it was not above 0·40, and sometimes fell to 0·25. When the iron had a surface even imperfectly polished, k never rose above 0·40, and was generally not more than 0·20 or 0·30, and sometimes fell to 0·17 and even to 0·12 (indifferently too, as to whether the rails were dry or

moist or even greasy, except in the latter case, when the rubbing surface was relatively small, that is, when the specific pressure was great; then the co-efficient of friction of iron with a greasy lubric was very much diminished). In the friction of wood and leather with a greasy lubric, k generally fell to 0·16, sometimes only to 0·20, but sometimes too to 0·05. Moreover, the grease always favored the rapid production of polish on the surfaces, and consequently the diminution of friction in this way. It is principally thus, and consequently indirectly, that the greasy lubrics act to diminish the friction.

It is especially at the starting and at very low velocities that the frictions differ very much from each other, according to the circumstances. In proportion as the velocity increases, the different frictions, all diminishing, ordinarily in proportion to their value, generally approximate to each other.

This approach to a common value takes place also the more, in proportion as the rubbing surfaces are more polished, which condition is best produced and maintained by lubricating the surface with a greasy substance.

Thus we may say that all substances well polished sliding rapidly, and under a moderate specific pressure, have all nearly the same very small co-efficient of friction. But outside of this very peculiar combination of circumstances, nothing is more changeable with the conditions than friction.

Patera's Process for Extracting Silver from its Ores. By Clement Le Neve Foster.

From the Journal of the Society of Arts, No. 422.

The process in question was originally suggested by Dr. Percy, F. R.S., of the Government School of Mines, and has been of late years taken up and carried out on a large scale by one of the most celebrated metallurgical chemists in Austria, viz., Herr von Patera. This process is of special interest, on account of the analogy it presents with the well-known "fixing" in photography, which is nothing more than dissolving out the chloride of silver (which has not been acted on by light) by means of hyposulphite of soda.

In the metallurgical process this property is made use of in the following manner:—The ores which contain the silver in combination with sulphur, or with sulphur and arsenic, are roasted with green vitriol and common salt, and thus is produced a chloride of silver which may be dissolved out by a solution of hyposulphite. The silver can then be precipitated by sulphide of sodium, falling down as sulphide of silver. All that is necessary to be done then is to heat the sulphide in a muffle in contact with the atmosphere; the sulphur escapes in the form of sulphurous acid, and the silver remains in the metallic state. It is then melted in plumbago pots and cast into ingots for the mint. Such is a rough outline of the process which is now, and has been for some years, in operation at Joachimsthal, on the northern frontier of Bohemia. The ores which are subjected to this process are rich in silver,

containing on an average two per cent., but often as much as ten per cent. Ores containing less than one per cent. are melted down with pyrites in a cupola blast furnace for regulus or *matte*, which is then treated as the ore.

The advantages of this process are manifold: 1st, ores containing large amounts of arsenic can be thus successfully treated, when Ziervogel's process would fail; 2d, the expense of heating a strong solution of salt, as in Augustin's process, is got rid of, as the hyposulphite is used cold; 3d, the hyposulphite filters quicker and better than the brine in Augustin's process, for the dissolving power of hyposulphite being great, a weak solution may be used; 4th, the solution of hyposulphite may be used over and over again, for it is being continually renewed, and as this is one of the peculiar points in the process, it deserves particular attention. The precipitation of the silver is effected, as has been before stated, by sulphide of sodium, and this is a polysulphide, for it is prepared by calcining soda with sulphur and then boiling it with sulphur. In this manner a polysulphide of sodium is formed, but in contact with the air some hyposulphite of soda is generated, and thus, each time that the silver is precipitated, some hyposulphite of soda is added to the solution. In this way Herr von Patera, who commenced with 14 lbs. of hyposulphite of soda (and who yearly extracts more than 3000 lbs. of silver), has never needed a fresh supply, and has, in fact, been obliged to throw away quantities of solution, as his stock was always increasing. The expense of this process is not great; the extraction of a pound of silver from the ore costs, on an average, only 9*s*. 9*d*., whilst by the method of smelting formerly in use, the cost of production of a similar quantity of metal was no less than 16*s*.

For the Journal of the Franklin Institute.

Strength of Materials: Deduced from the latest experiments of Barlow, Buchanan, Fairbairn, Hodgkinson, Stephenson, Major Wade, U. S. Ordnance Corps, and others. By Chas. H. Haswell, Civil and Marine Engineer.

No. 7.

(Continued from page 252.)

Deflection of Bars, Beams, Girders, &c.

From the experiments of Barlow on the deflection of wood battens, he deduced that the deflection of a beam from a transverse strain, varied as the breadth directly and as the cubes of both the depth and length, and that with like beams and within the limits of elasticity it was directly as the weight.

These deductions are supported by the particular experiments referred to, and although they have been subsequently supported by the experiments of Hodgkinson on cast iron bars, having like conditions of proportionate section to length, an extended examination of the subject, aided by further elements, will show that, however correctly these

laws may apply in the cases referred to, they are inapplicable in varied conditions of section, length, and material.

If the lines of deflection of bars, beams, &c., were right lines, meeting at the point of bearing of the stress, or in other words, in the neutral axis of the section at that point, the deflection would be directly as the resistance of the bar, beam, &c., to transverse stress, inasmuch as the point of rupture of the fibres, or of the material of the bar, &c., would depend upon the angle of the bar, at the point of the application of the stress, and the measure of the angle, being the versed sine of it, would be the same, without reference to the length of the bar, as in like angles, the versed sines are directly as the length of their bases. Thus, if the deflection of a bar, 10 feet in length between its supports, was 5·25 inches, the angle of deflection from a horizontal plane would be five degrees; *hence*, the angle of deflection at any other length would be the same, and, consequently, the resistance of a bar, &c., to deflection alike to that of transverse strain, would be directly, as its length. It occurs, however, that the line of deflection is that of a curve; *hence*, although the angle of rupture, measured from the neutral axis of the section of the bar, &c., would be the same, yet this angle, in consequence of the curvature of the plane of the bar, &c., will be depressed in proportion to the curvature, and whilst it remains the same, the deflection or versed sine of the angle of the neutral axis of the section and the plane of the bar, &c., at the points of support, will be increased proportionate to the versed sine of the arc of curvature.

Therefore, in bars, beams, &c., of an elastic material, and having great length compared to their depth, the deductions of Barlow will apply with sufficient accuracy for all practical purposes; but in consequence of the varied proportions of depth to length of the varied character of materials, of the irregular resistance of beams constructed with scarphs, trusses, or riveted plates, and of the unequal deflection at initial and ultimate strains, it is impracticable to give any positive laws regarding the degrees of deflection of different and dissimilar bars, beams, &c.

In the experiments of Hodgkinson, it was further shown that the sets from deflections was very nearly as the squares of the deflections.

In a rectangular bar or beam, the position of the neutral axis is in its centre, and it is not sensibly altered by variations in the amount of strain applied. In bars or beams of cast and wrought iron, the position of the neutral axis varies in the same beam, and is only fixed whilst the elasticity of the beam is perfect. When a bar or beam is bent so as to injure the elasticity of it, the neutral line changes and continues to change during the loading of the beam until it breaks. When a beam is supported at the ends and loaded in its middle with different small weights, they are reciprocally proportional to the radius of curvature at that point, and the curvature itself is consequently proportional to the weight.

When a Bar or Beam is fixed at one End and loaded at the Other, the fundamental property of the curve of deflection is, that the curva-

ture at every point is as the distance of that point from the line of direction of the weight.*

The quantity of extension in consequence of the imperfect elasticity of the fibres of materials is very irregular, and after a certain deflection has been obtained, it is subject to no determinate law; but while the weight or strain upon the fibres is considerably less than that which is required to produce fracture, the law of deflection for each case is nearly uniform, and proportional to the exacting force.

When beams are of the same length, the deflection of one, the weight being suspended from one end, compared with that of a beam uniformly loaded, is as 8 to 3, and when a beam is supported at both ends, the deflection in like cases is as 5 to 8.

Whence, if a beam is in the first case supported in the middle and the ends permitted to deflect, and in the second, the ends supported and the middle permitted to descend, the deflection in the two cases is as 3 to 5.

Of three equal and similar beams, one inclined upward, one inclined downward at the same angle, and the other horizontal, it has been determined that that which had its angle upward was the weakest, the one which declined was the strongest, and the one horizontal was a mean between the two.

When a beam is *uniformly loaded*, the deflection is as the weight, and approximately as the cube of the length, or as the square of the length and the element of deflection and the strain on the beam, the weight being the same, will be but one-half of that when the weight is suspended from one end.

The deflection of a beam *fixed at one end* and *loaded at the other*, compared to that of a beam of twice the length *supported at both ends* and *loaded in the middle*, the strain being the same, is as 2 to 1, and when the length and the loads are the same, the deflection will be as 16 to 1, for the strain will be four times greater on the beam fixed at one end than on the one supported at both ends; therefore all other things being the same, the element of deflection will be four times greater: also, as the deflection is as the element of deflection into the square of the length, *then*, as the lengths at which the weights are borne in their cases are as 1 to 2: the deflection is as $1 : \overline{2^2 \times 4} = 1$ to 16.

The deflection of a beam having the section of a triangle, and supported at its ends, is one-third greater when the edge of the angle is up, than when it is down.

When the Length is Uniform, with the same weight, the deflection will be inversely as the breadth and square of the depth into the element of deflection, which is itself inversely as the depth. *Hence*, every thing else being the same, the deflection will vary inversely as the breadth and cube of the depth.

Illustration.—The deflections of two pine battens, of uniform breadth and depth, and equally loaded, but of the lengths of 3 and 6 feet, were as 1 to 7·8.

If a beam is cylindrical, the deflection is 1·7 times that of a square beam, other things being equal.

* See Barlow on Materials and Construction, p. 67.

The following are the deductions of Mr. Barlow consequent upon the preceding:

When a Beam is Fixed at one End and Loaded at the Other.

$$\frac{l^3\,w}{b\,d^3\,D} = V, \textit{ a constant quantity.}$$

When a Beam is Fixed at one End and Uniformly Loaded.

$$\frac{3\,l^3\,w}{8\,b\,d^3\,D} = V.$$

When Fixed at Both Ends and Loaded in the Middle.

$$\frac{l^3\,w}{24\,b\,d^3\,D} = V.$$

When Supported at Both Ends and Loaded in the Middle.

$$\frac{l^3\,w}{16\,b\,d^3\,D} = V.$$

When Supported at Both Ends and Uniformly Loaded.

$$\frac{5\,l^3\,w}{8\times 16\,b\,d^3\,D} = V.$$

When Supported in the Middle and the Ends Uniformly Loaded.

$$\frac{3\,l^3\,w}{5\times 16\,b\,d^3\,D} = V.$$

When Supported at Both Ends and the Weight Suspended from any other Point than the Middle.

$$\frac{m^2\,n^2\,w}{l\,b\,d^3\,D} = V.$$

l representing the length in inches, b its breadth, d its depth, w the weight or strain with which it is loaded, m n the distances of the weight from the supports, and D the deflection in inches.

Hence, in order to preserve the same stiffness in beams, the depth must be increased in the same proportion as the length, the breadth remaining constant.

The deflection of different beams arising from their own weight, having their several dimensions proportional, will be as the square of either of their like dimensions.

NOTE.—In the construction of models on a scale, intended to be executed in full dimensions, this result should be kept in view.

With regard to the ultimate deflection of beams before their rupture, the same relations do not exist, as when the depth is the same, the element of deflection will, in the breaking state of a beam, be constant; consequently, the ultimate deflection will, in this case, be as the square of the length, and it will be inversely as the depth, when the length is the same; and if both these dimensions remain constant, the last deflection will be constant also, whatever may be the breadth of the beam.

TABLE *of the Results of Experiments on the Deflection of Battens, Bars, Beams, and Girders of Various Sections and Materials;* observed by Major Wade, U. S. Ordnance Corps, Barlow, Buffon, Fairbairn, Hodgkinson, Stephenson, &c., &c.,

Bar, Beam, &c., Supported at Both Ends, Weight or Strain applied in the Middle.

MATERIAL AND SECTION.	Length of bearing.	Breadth.	Depth.	Depth of opening.	Weight.	Deflection.	Value for general use. $\frac{l^3 \text{ W}}{16\, b\, d^3\, \text{D}} = \text{V}.$
WOODS.	Ft. Ins.	Inch.	Inch.	Inch.	lbs.	Inch.	
Fir. Rectangle,	3	1·5	2·	—	120	·090	187
Square,	4	2·	2·	—	420	·360	292
Rectangle,	4	3·	1·5	—	120	·270	153
"	6	3·	1·5	—	120	·937	170
"	6	1·5	3·	—	120	·260	154
"	6	1·5	2·		120	·680	108
"	8	3·	1·5	—	120	2·045	185
"	10	1·5	3·	—	120	1·050	177
Ash. Cylinder,	3 10	2·	2·	—	715	2·700*	58
Hollow do.,	3 10	2·	2·	·5	657	2·500*	58
Square,	7	2·	2·	—	75	·422	238
"	7	2·	2·	—	225	1·266†	238
Yellow Pine. Square,	5	·75	·75	—	16	1·500	250
"	5	·75	·75	—	40	6·250*	158
. . .	5	1·5	1·5	—	16	·190	133
. .	5	1·5	1·5	—	16	·310	80
Square,	7	2·	2·	—	150	1·134†	178
Elm. Square,	6	2·	2·	—	125	1·685†	62
Beech. Square,	7	2·	2·	—	150	1·026†	196
Oak. Square,	3	1·	1·	—	158	2·950	91
"	7	2·	2·	—	150	1·500†	146
"	6	2·	2·	—	200	1·280†	132
"	15	5·35	5·35	—	6000	8·570	180
"	30	5·35	5·35	—	2330	19·780	240
Rectangle,	2	·75	1·5	—	323	1·500	43
Pine. Rectangle,	40	7·5	9·25	—	1700	5·250	218
"	40	7·5	9·25	4·625	1700	3·500	327
"	40	7·5	18·5	9·25	1700	2·250	63
"	40	7·5	22·375	13·125	1700	1·125	72
METALS.							
Cast Iron, English.	2 10	1·	1·	—	300	·160†	2607
"	2 10	1·	1·	—	1008	·625	2278
Mean English,	4 6	1·	1·	—	471	1·675	1589
Swedish.‡	3	1·	1·	—	884	·500†	2983
English. Square,	4 6	1·	1·	—	56	·135	2551
"	4 6	1·	1·	—	112	·259	2362
"	4 6	1·	1·	—	448	1·535	1634
"	4 6	1·	1·	—	440	1·779*	1432
"	6 9	3·	3·	—	112	·012	2219
"	9	2·	2·	—	112	·167	1910
Mean of mixture and blasts, do.,	4 6	1·	1·	—	481	1·366*	1992
English. Square,	13 6	3·	3·	—	112	·092	2311
Rectangle,	10	2·	1·	—	56	·480	3660
"	13 6	3·	1·5	—	56	·323	2634
"	13 6	6·	1·5	—	56	·165	2573

* Breaking weight. † Elasticity perfect.

‡ Barlow deduced from this that, as a mean, 1000 lbs. is the load that will destroy the elasticity of a bar of wrought iron 1 inch square and 3 feet long between the supports; and Mr. Drewry assumes that a like bar will be deflected a quarter of an inch by 560 lbs., and that it is not safe to load it permanently with 266 lbs.

TABLE *of the Results of Experiments on the Deflection of Battens, &c., (Continued).*

MATERIAL AND SECTION.	Length of bearing.	Breadth.	Depth.	Depth of opening.	Weight.	Deflection.	Value for general use. $\frac{l^3 w}{16\ b\ d^3\ D} = V.$
METALS (Continued).	Ft. Ins.	Inch.	Inch.	Inch.	lbs.	Inch.	
American mean,							
2d fusion. Square.	1 8	2·	2·	—	10800	·117†	1656
3d " "	1 8	2·	2·	—	9000	·088‡	1840
Chilled, "	1 8	2·	2·	—	10800	·051‖	3821
Dry sand, "	1 8	2·	2·	—	10800	·110	1761
Green sand, "	1 8	2·	2·	—	5000	·045†	2000
2d fusion. Cylinder,	1 8	2·	2·	—	10800	·161§	1205
▽ • •	4 6	2·	1·43	—	168	·106	2407
Hot blast. Square,	5	1·	1·	—	225	·110¶	1562
Cold " "	5	1·	1·	—	225	·085¶	2008
20 p. c. wrought iron, "	4 6	1·	1·	—	112	·202	3189
10 " " "	4 6	1·	1·	—	511	1·560	1940
2·5 " nickel, "	2 3	1·	1·	—	860	·520*	1180
Flanch 5· × ·3	6 6	·36	1·55	—	112	·273	5302
	6 6	·36	1·55	—	336	1·030	4191
" "	6 6	·36	1·55	—	112	·270	5302
	6 6	·36	1·55	—	336	·895	4850
" 1·5 × ·5	3 1	·5	3·	—	672	·027	3360
" "	3 1	·5	3·	—	672	·025	3609
" "	3 1	·5	3·	—	2016	·079	3534
" "	3 1	·5	4·**	1·5	2016	·051	2302
" "	3 1	·5	3·**	1·5	2016	·052	5364
" 23·9 × 3·125	23 1	3·29	36·1	—	60000	·100	2983
" " "	23 1	3·29	36·1	—	136000	·220	2940
" " "	23 1	3·29	36·1	—	230000	·420	2720
" " 6·5 × 1· area 18·5	15	·91	14·	—	4480	·300	1261
" 4·5 × ·875 9· × 1·25	22	1·12	36·	—	22400	·094	3034
" " 9· × 1·625 18· × 2·75	50	2·	36·	—	22400	·187	9618
" " 4·125 × 1·5 15· × 2·25	30 9	1·5	24·5	—	44800	·469	7998
					72000	·870	6847
" 2·72 × ·83 5·9 × 8·4 area 18·1	15	·68	17·25	—	4480	·150	1808

* Breaking weight. † Elasticity perfect. ‡ ·020. ‖ ·003. § ·022 ¶ Permanent set. ** Depth of opening, 3 ins.

TABLE *of the Results of Experiments on the Deflection of Battens, &c., (Continued).*

MATERIAL AND SECTION.	Length of bearing	Breadth.	Depth.	Depth of opening.	Weight.	Deflection.	Value for general use. $\frac{l^3 w}{16\ b\ d^3\ D} = V.$
METALS (Continued).	Ft. Ins.	Inch.	Inch.	Inch.	lbs.	Inch.	
Flanch. 1·6 × ·315 4·16 × ·53	4 6	·38	5·125	—	11186	·400	3113
" " 2·3 × ·28 6·61 × ·54	4 6	·34	5·125	—	12087	·260	5783
" " 2·25 × ·33 6· × ·74	7	·4	4·1	—	2900	·250	9023
" " 2·15 × ·24 7·60 × ·72	4 6	·39	5·125	—	12800	·250	5552
" " do.,	9	·40	5·125	—	10500	1·450	6128
Rectangular, area 1·965	4 6	·975	2·015	—	712	·280	1817
Open beam, area 2·	4 6	1·	2·5	·50	712	·132	1965
" "	4 6	1·	3·	1·	712	·085	1766
" "	4 6	1·	4·	2·	712	·040	1582
Curved bars, versed sine 1·44 in.	9	1·	3·	—	1456	·38	6464
" " ·63 in.	9	1·	3·	—	1778	·61	4919
Wrought Iron. Square,	2 9	2·	2·	—	2240	·068	2677
"	2 9	2·	2·	—	4480	·128	2748
Round,	5 6·5	1·25	1·25	—	58	·125	1905
Rectangle,	2 9	1·5	3·	—	2240	·074	970
Swedish. Square,	5 6·5	1·	1·	—	58	·125	4812
Flanch. 4·5 × ·5 Rib, 3·25 diam.,	10 3	·5	10·	—	3136	·375*	11258
" 3·5 × ·6	2 7	·8	3·5	—	6720	·033	6384
Flanch. 2·75 × 1· 4·3 × ·44	10	·35 ·35	8· 8·	— —	4360 12980	·12 ·3	12674 15058
" 2·85 × ·41	4	·29	2·5	—	1960	·240	7209
Flanches, 2 of 2·25 × ·28 do. 2·25 × ·3	7	·25	7·	—	16480	·250	16479
Flanch 6 × ·375 12 × 5·75 Angle iron, 2·5 × 2·5 × ·5 3·5 × 3·5 × ·5	28 6	·375	12·5	—	13000	1·	2653
Flanch 12 × ·375 4 × ·375 Angle iron, 2·5 × 2·5 × ·375 1·75 × 1·75 × ·375	28 6	·375	12·125	—	20700	2·250†	19911

* Permanent set. † Ibid, ·4375.

TABLE *of the Results of Experiments on the Deflection of Battens, &c., (Continued).*

MATERIAL AND SECTION.	Length of bearing.	Breadth.	Depth.	Depth of opening.	Weight.	Deflection.	Value for general use. $\frac{l^3 \, w}{16 \, b \, d^3 \, D} = V.$
METALS (Continued.)	Ft. Ins.	Inch.	Inch.	Inch.	lbs.	Inch.	
Flanches, 9 × 16 ins., Angle iron, 4 ×	40 5	·75	24·	—	35000	1·250‡	11196
Tubes, thickness ·63 in.	3 9	1·9	3·	—	448	·100	287
" " ·1325 in.	7 6	3·9	6·	—	4376	·240	570
" " ·124 in.	30	15·	24·	—	5685	·490	96
" " ·250 in.	30	15·5	23·75	—	5685	·210	220
" " ·525 in.	30	15 5	24·	—	5685	·120	372
" top, ·437 in. / " bottom, ·272 in.	30	15·75	23·75	—	33685	·850	316
" " ·037 in.	17	12·	12·	11·925	2755	·650*	62
" " ·0954 in.	31	24·	24·	23·81	10236	·630*	91
Box girder with angle iron at angles. top plates ·375 bot. & sides ·125	9	6·	6·	—	7000	·250	984
Corrugated plates,	31 6	3·1	8·	—	4480	·62	8893
Tubes, thickness, ·0416 in.	17	9·25	14·62	13·535	2262	·620*	38
" " ·143 in.	17 5	9·75	15·	14·714	16800	1·390*	123
Steel, Cast. Soft,	3 2	·23	·52	—	22	·331	4245
Razor,	2 2	·30	·57	—	22	·083	2984
Brass. Cast,	1	·7	·45	—	60	·040†	1469
GUN METAL.							
Copper 8. Tin 1,	1	·7	·5	—	100	·050†	1428

* Breaking weight. † Elasticity perfect. ‡ Permanent set, ·625.

(To be Continued.)

On a new Alkali-Metal. By MM. BUNSEN and KIRCHHOFF.

From the Lond. Chemical News, No. 51.

In a recent number of the *Philosophical Magazine* there is given an account of some researches by MM. Bunsen and Kirchhoff on the effect produced by various metals on the spectrum of a flame in which their chlorides are volatilized. That part of their investigation which is more particularly interesting consists of a method of photo-chemical analysis of exquisite delicacy, which the authors have specially studied in relation to the alkali-metals.

These metals have been employed in the form of chlorides, which

have been purified with the greatest care. When these are introduced into a jet of flame they volatilize to a greater or less extent, and then communicate to the flame the special character above alluded to, and which is observable when the spectrum produced by the flame is examined by a sufficient magnifying power.

The above-named memoir is accompanied by a colored plate which illustrates the spectra of the alkali-metals with their characteristic rays. These rays are the more visible in proportion as the flame is less luminous and its temperature higher. The ordinary Bunsen gas-burner answers admirably for these experiments. The rays shown by the chlorides of potassium, sodium, and lithium are perfectly well defined; those of barium, strontium, and calcium are more complicated, and require a somewhat experienced eye for their identification. They are, however, quite distinct enough to be easily recognised, even when salts of these metals are mixed together; for the great advantage of this method of analysis is, that foreign matters have no influence on the results, the authors being able to detect with certainty the different elements in a mixture containing the tenth of a millegramme of the metals mentioned above. Sodium, with its yellow ray, first appears; after that the well defined red ray of lithium; next is seen the paler rays indicating potassium; and, after these rays have disappeared, they are replaced by those of calcium and strontium, which remain visible for some time. The absence of one or other of these sets of rays shows the absence of the corresponding metals.

We are, then, by this method placed in possession of an analytical process of the most extraordinary delicacy. The researches of our authors prove that this sensibility almost approaches the infinite, the eye being able, by its means, to recognise the presence of the three-millionth part of a millegramme of chloride of sodium. It must not, therefore, be a matter of surprise to find sodium distributed almost everywhere, especially in the atmosphere, in which is almost always a sufficient quantity to show the sodium ray. The same may be said in great measure of lithium. In a room of a capacity of about 60 cubic metres was exploded a mixture of sugar-of-milk and chlorate of potassa, containing 9 millegrammes of carbonate of lithia. The lamp, being placed at some distance off, became quickly colored, so that the red ray could be distinctly visible in the spectrum. The authors estimated that this sensibility reached the nine-millionth part of the amount taken.

After this it must not be a matter of surprise to find that lithium is one of the widest-spread elements. The water of the Atlantic was found to contain it. It was also found in the ashes of plants grown on a granite soil, in the vine, in tobacco, and also in milk and in human blood. In the mother-liquors of tartaric acid manufactories, the lithia is found to be so concentrated as to be worth commercial extraction; and the same may be said of certain mother-liquors of saline springs.

With so delicate a reaction as the one just described, of an almost infinite sensibility, and applicable to all metals, the presence of ele-

ments, existing in so small quantities as to entirely escape ordinary analysis, may be rendered visible. Many observations tended to this point, and MM. Bunsen and Kirchhoff now announce definitely (*Annal. der Physik und Chemie*) that they have discovered a new alkali-metal, the fourth member of the group of potassium, sodium, and lithium. At present they have only found it in very small quantities in the mineral water of Kreuznach, in the saline water of Durreckeim, and in one of the sources of the Bade—the Umgemach.

The chloride of the new metal differs from those of sodium and lithium by the yellow precipitate which it produces in the presence of bichloride of platinum. It is distinguished from potassium by its nitrate being soluble in alcohol. Introduced into a flame, and examined with a prism, the vapors of the new chloride show a very interesting spectrum, consisting of two blue lines, one of which, the fainter, almost corresponds with the blue of strontium; the other, also a well defined blue line, is situated a little further towards the violet extremity of the spectrum, and rivals the lithium line in brightness and distinctness of outline.

On the Surface-Condensation of Steam. By J. P. Joule, LL. D., F. R. S.

From the Lond. Artizan, Feb., 1861.

In the author's experiments steam was passed into a tube, to the outside of which a stream of water was applied, by passing it along the concentric space between the steam tube and a wider tube in which the steam tube was placed. The steam tube was connected at its lower end with a receiver to hold the condensed water. A mercury gauge indicated the pressure within the apparatus. The principal object of the author was to ascertain the conductivity of the tube under varied circumstances, by applying the formula suggested by Professor Thomson,

$$c = \frac{w}{a} \log \frac{V}{v},$$

where a is the area of the tube in square feet, w the quantity of water in pounds transmitted per hour, V and v the differences of temperature between the inside of the steam tube, and the refrigerating water at its entrance and its exit. The following are some of the author's most important conclusions.

1. The pressure in the vacuous space is sensibly the same in all parts.

2. It is a matter of indifference in which direction the refrigerating water flows in reference to the direction of the steam and condensed water.

3. The temperature of the vacuous space is sensibly equal in all its parts.

4. The resistance to conductivity must be attributed almost entirely

to the film of water in immediate contact with the inside and outside surfaces of the tube, and is little influenced by the kind of metal of which the tube is composed, or by its thickness up to the limits of that of ordinary tubes.

5. The conductivity increases up to a limit as the rapidity of the stream of water is augmented.

6. By the use of a spiral of wire to give a rotary motion of the water in the concentric space, the conductivity is increased for the same head of water.

The author, in conclusion, gives an account of experiments with atmospheric air, as the refrigerating agent; the conductivity is very small in this case, and will probably prevent air being employed for the condensation of steam except in very peculiar circumstances.

Incrustation in Steam Boilers. By Henry Ransford.

From the Journal of the Society of Arts, No. 424.

All the world knows that the incrustation in steam boilers is deposited from the water, and that, in tubular boilers, it is very difficult to get rid of; but few are aware that "blowing out" a boiler, to get rid of the sediment on the bottom, hardens the sediment that adheres to the tubes, converting it into a calcareous shell, requiring a smart blow of a hammer to dislodge it.

Will you oblige me by giving to the world, through the columns of your *Journal*, a very simple and efficacious remedy?

I tried the experiment on a 30-horse tubular boiler. In addition to the blow-off cock at the bottom another was fitted over the fire-pan, at the usual level of the water, and to the end of it, inside the boiler, was screwed on a funnel of sheet iron, partly flattened, so that, on the cock being opened, anything floating within eight or ten inches on each side was drawn through.

The engine-driver had directions to open the lower cock once a day, and the upper one when he saw the water in the glass gauge was thick, and keep them open until the water ran clear, but never to blow out the boiler as formerly. Three or four gallons from the lower, and half that quantity from the upper cock was sufficient to carry off all thick and dirty water.

At the end of *three months*, first allowing the water to get nearly cold, the boiler was emptied; a stream of water was then introduced by the man-hole, and the tubes thoroughly washed. On examination the under half of the tubes was as clean as the day they were made, the upper half discolored, but no scale, and the sides of the boiler in a similar state; on the bottom was about a half bushel of thin scale, broken up into small pieces, that apparently had fallen or been washed from the tubes; thus, after three months' work, there was nothing to do but to get up steam again.

The secret consists in never blowing out the boiler when hot, the usual custom, as the result is—the heat of the tubes and sides instan-

taneously convert the soft deposit into a hard calcareous substance, and every time the boiler is blown out an additional stratum is added. If the man-hole is taken off on Saturday afternoon, and the flues opened, the water is cold enough to run off by Monday morning, so that no time is lost, and I have no doubt the hot water might be allowed to run off on the Saturday provided an equally large stream of cold water was allowed to run in at the same time, until the boiler and tubes were cold. I will merely add, the water was pumped from the Thames, and allowed to settle, before being used for the boiler. There is no reason why the plan should not answer equally well for locomotives.

Brompton, Dec. 19th, 1860.

For the Journal of the Franklin Institute.

The Manufacture of Cast Iron Pipes. By Ed. Brandt, Esq.

At the expense of much time, and subjecting myself to no inconsiderable labor and inconvenience, I have been enabled to accumulate the annexed particulars, which were the prominent features embodied in a Report upon the manufacture of cast iron pipes, submitted by John H. Rhodes, Esq., Inspector, &c., to the Chief Engineer of the Water Works, Brooklyn, New York. It deserves the closest perusal of all who are in any way whatever connected with water pipe castings, as its descriptions of the defects most usual, with those that only periodically and under certain circumstances occur, are clearly given, together with such rules and suggestions as will enable manufacturers to avoid them in the future.

As it will be observed, the Report compares the vertical pipe castings with the horizontal, and advocates the former.

The acceptance of defective castings and their use in the pipe distribution of a city, create, sooner or later, leaks and breaks in the works of which they become a part, causing much trouble and expense to the public; therefore, that intelligence which will cause the arrest of such imperfections in the manufacture of cast iron pipes should commend itself to the attention of public authorities, as well as that of manufacturers, inspectors, &c.

Mr. Rhodes says:

Sir:—Having concluded the duties to which I was ordered by you, I now present my Report, together with such information in reference thereto as I have been enabled to obtain.

In the course of the discharge of my duties, I have found a great proportion of the work so faulty as to lead me to a critical examination of the manner of manufacturing, and the cause of the defects. The proportion of bad pipes which I have from time to time met with has been so great (sometimes as high as 50 per cent.) as to create great doubt as to whether the remainder would be practically safe, although showing no defects to the eye or weakness under the application of the required pressure. I have observed, and hereafter shall endeavor

to show, that in casting pipes horizontally, difficulties present themselves which are almost insurmountable. A perfect pipe cast in this manner is the exception and not the rule, inasmuch as these difficulties are in themselves, not mechanical but natural, and are peculiar to the manner of moulding and casting it. I shall further endeavor to show that the main difficulties met with, in casting pipes horizontally, may be avoided by casting vertically, thereby insuring the greatest degree of safety and durability.

In accordance with your orders, I proceeded to the foundry of Messrs. Colwell & Co., at Conshohocken, Pa., on the day appointed, to inspect and prove the pipes under the contract of Messrs. H. S. Welles & Co., for the Brooklyn Water Works, where I continued to discharge that duty for six consecutive months, during which time I inspected and proved 6432 pipes, consisting of 3369 6-in., 2230 8-in., 423 20-inch, and 250 30-inch, rejecting, upon inspection under proof, 158 6-inch, 98 8-inch, 58 20-inch, and 14 30-inch. A very considerable number in addition, were rejected without subjecting them to the proof. The above were rejected from one or more of the following causes, viz: blisters, sand holes, shrinkage cracks, air cells, and cold shuts.

The 6-inch and 8-inch pipes were cast in green sand moulds with green sand cores, placed horizontally. These were more particularly liable to defects from sand holes and shrinkage cracks, and occasionally from blisters; the first being caused from the cutting of the cores, or moulds, or both, from the abrasion of the hot metal in flowing through the mould, or by the core or mould having been injured or loosened in closing the flask. Many are also objectionable from their uneven thickness. The cause of these difficulties being attributable, in a great measure, to the *manner* of moulding and casting them, will be more particularly explained hereafter.

The 20-inch and 30-inch pipes were cast vertically with the "hub" end down in "dry sand moulds" and "loam cores." The loss upon these was mainly attributable: 1st, to an intermixture of sand or scoria with the iron; 2d, the washing off of the blacking from the mould or core, not unfrequently forming a "parting" of the iron nearly or quite through the thickness of the pipes; 3d, "cold shuts" in the body of the pipe; 4th, shrinkage recesses in the "hub"; 5th, "air cells" through the centre of its thickness; the latter being caused principally by an improper admixture of the sand used in forming the mould. One, and the great cause of failure in casting pipes vertically, may be found in the fact that the casting is not poured with sufficient rapidity, but by dribbling the iron through a back runner until the mould is half filled, then pouring the residue from above through small gates or openings, and an insufficient number of them has necessarily led to the castings being imperfect from "cold shuts," "air cells," and not unfrequently a large recess in the "hub," almost hidden from sight. This may be readily explained in this way: the iron having poured too long from the back runner, making the heat intense at the point of its connexion with the "hub" long after the rest of the pipe had

chilled, leaving, consequently, no means for the shrinkage at that point to receive metal to fill the space made by its contraction.

Subsequently to the visit made at Conshohocken, I received your orders to proceed to the works of the Warren Foundry and Machine Co., N. J., who were then engaged in casting 6-inch, 8-inch, 12-inch, 20-inch, 30-inch, and 36-inch pipes for the Brooklyn Water Works. Upon entering on my duties there, I found 107 6-inch, 53 8-inch, and 24 12-inch pipes ready for inspection. Upon examination I accepted but 62 of the 107 6-inch, but 19 of the 53 8-inch, and 7 of the 24 12-inch. The proportion of perfect pipes was so small as to create no inconsiderable excitement within myself, and very great apprehension among the stockholders of the Company; so much so, that after a few subsequent trials they gave up as impracticable the casting of small pipes as a source of profit, believing that they would not be able to fulfil the contract for that class of pipes without subjecting themselves to great loss.

The manner of moulding these differed materially from those cast at Conshohocken. They were cast in "green sand moulds" and "loam core," set up at an angle of about ten degrees, poured from one end of the flask. A very large proportion of them were "blistered." "Sand holes" were common, and the "cope," or tops of the pipes were very thin near their centre of length, caused by the springing of the "core bar," and that difficulty being frequently increased by the scorching of the straw rope while in process of drying, thereby causing it to loosen and rise upon the bottom and sides of the "core bar" by the pressure of the surrounding iron while being cast, or it may be very thin from the "boiling" of the metal in consequence of the core not being dry. It is thus evident that an accurate judgment is necessary in preparing the cores. I shall refer to this part of the subject and explain more fully hereafter.

I now come to the consideration of the 20-inch, 30-inch, and 36-inch pipes, which were so successfully cast at this foundry by Messrs. Firth & Ingham, who were sub-contractors with the Warren Foundry & Machine Co., to cast these pipes and deliver them ready for inspection. To this firm is essentially owing the great success which has been achieved in casting the force mains and large branches for the works. I take great pleasure in having an opportunity to state that they have scarcely lost a pipe in casting that has not been owing to improper material accidentally furnished them.

These pipes have undergone a very severe inspection and proof, in effecting which (although the loss, if rejected, fell upon them), I have always received their hearty co-operation, and I have to record that I have not in a single instance known them to make an attempt to conceal imperfections; upon the contrary, they were gentlemanly and communicative upon all matters relevant to my duties, and I have derived from them great practical information. I have here inspected 112 20-inch pipes, rejecting 2; 113 30-inch pipes, rejecting 2; 74 36-inch pipes, rejecting 4; 32 30-inch bevel hubs, rejecting 1; 40 36-inch bevel hubs, rejecting 1; force mains 1½-inch thick, 196 36-inch, re-

jecting 4; force mains 1⅞-inch thick, 158 36-inch, rejecting 8; force mains 1¼-inch thick, 356 36-inch, rejecting 4; force mains 1⅛-inch thick, 126 36-inch, rejecting 5. (I am led to believe, upon examination, that the strongest and soundest pipe of 36-inch diameter is much in favor of a weight not variable far from 3600 to 4000 lbs.) Increased care became necessary in order to make sound castings 1½ inches thick, as the increased thickness caused the centre of the pipe (in reference to thickness) to remain much longer in a fluid state, and particularly so at the "hub" end, where there is a very much larger amount of metal that in shrinking was continually drawing from the centre of the pipe (in thickness), rendering it necessary to "churn" the runners and continue the supply of hot metal for some time after the cast was "up."

I believe that 36-inch pipes of over 3600 lbs. weight might be cast to advantage six inches over the required length, to be subsequently cut off in a lathe. Had this course been followed, we should have lost none of that diameter, as I have met with no unsoundness in that class of pipes which has extended more than that distance from the spigot end, rarely more than two inches.

Having thus had an opportunity of comparing the relative merits of the various modes or plans pursued in casting iron pipes, I am fully convinced from my experience that *all* pipes, large or small, should be cast *vertically*. In order to show how I have been thus convinced, I will make a comparison between "green sand" pipes, cast horizontally or inclined, and "dry sand" pipes, cast vertically. In order to do so, I will now give a particular description of, and examine:

First, the defects of the system of making "green sand" pipes with "*loam* cores."

Second, the defects of the system of making "green sand" pipes with "*green sand* cores."

Third, I will endeavor to show how their defects may be avoided by casting pipes vertically in "dry sand moulds" and "loam cores."

First.—The defects of the system of making "green sand" pipes with "loam cores" are so various, that in order to explain them clearly, it will be necessary to examine them in detail. For that purpose I will classify them as follows, viz:

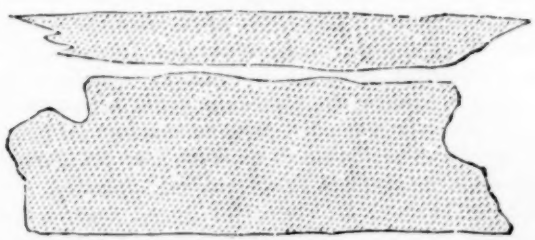
1. Their tendency to unevenness in thickness.
2. The cause of "blows" or "blisters."
3. The causes that tend to weaken the side of the pipe lying uppermost in the mould.

First. Green sand pipes with loam cores, are generally uneven in thickness, often to the extent of one-half or more of the required thickness of the pipe. This unevenness is caused in at least five different ways, and each of these causes of irregularity may be at work together or separately.

1. The spring of the core bars by the lift on them. On a 12-inch core, when the pipe is cast at the usual angle of about ten degrees, it is about 3100 lbs., the weight of the core is about 700 lbs., so that the effective lift upon the core is about 2400 lbs. The lift upon an 8-inch core is about 900 lbs., and of a 6-inch core about 500 lbs. The spring of a 12-inch core bar is so small as to be of little importance, but as you decrease that diameter it becomes very considerable. The spring of an 8-inch core bar varies from $\frac{1}{16}$th to $\frac{1}{8}$th of an inch; a 6-inch core bar will spring from $\frac{1}{16}$th to $\frac{3}{16}$ths of an inch, and below that diameter it becomes necessary to use chaplets or nails.

2. The rising of the loam or coating on the bar. This may be caused by running the straw ropes on the core bar too close together, or through the ropes being too soft, or not drawn sufficiently tight; and as any of these evils are much easier upon the workmen than the proper way, they are often indulged in; but the principal cause of the rising of the loam core is the burning of the ropes in the drying oven by what is called "scorching or high drying," the object of which is to prevent "blisters" on the pipe. The adhering principle of loam is a vegetable matter which burns with the heat of the iron, thereby generating a gas, which is one of the principal causes of "blisters," and by scorching the core they thereby avoid a portion of it; but in scorching the loam they also scorch the straw rope, so that the base of the loam is partially destroyed, and the pressure of the iron (when casting the pipe) forces the loam close to the bar, and as the pressure of the iron acts upon the bottom of the core first, and then upon the sides, as it rises in the mould, the loam is wrapped close to the bottom and sides of the bar, and is consequently lifted upon the top, where it remains; for the pressure upon the iron at the bottom is greater than upon the top of the mould, and to that extent will the pipe be thinner upon the top than upon the bottom. The larger the diameter of the core, the greater the evil from the core rising from this cause.

Fig. 1.



The above diagram shows the full size of a specimen taken from the top and bottom side of a 16-inch pipe cast for the Hoboken Water Works.

3. The manner of securing the cores. They are wedged down at the ends by wooden wedges driven under the wooden handles of the flask, while the bearing of the core is a "sand print" of a few inches

in length. If they are wedged down too tight the core is forced too low, and if not wedged tight enough the core will rise. This is done with but little judgment, commonly by men who do not know how much the core will lift, or what pressure they are putting on the wedge.

4. It is common to set the core a little below the centre in the mould, as the core might rise, or the bar might spring, or the loam might rise upon the bar, and under any circumstances the top of the pipe is weaker than the bottom, and if a little thicker it would help it. With this system of moulding, it appears to me to be good judgment to place the core at least 20 per cent. of the thickness below the centre, being thus obliged at the outset to consent to and desire an uneven thickness of pipe at the ends in order to obtain the greatest mean strength.

As the transverse weakness of a pipe is mainly caused by the action of shrinkage (in an uneven pipe), it may be almost to a breaking point, and yet not be discovered until after the pipe has been laid in the ground, when its weight may cause them to break. If the pipe be uneven to a very considerable extent, and the shrinkage has dangerously affected it, it will not be straight, having been drawn from a straight line as follows: The side of the pipe that is thinnest will cool first and contract before the thick side; the thick side being in a semi-fluid state will yield to the strain; but the thick side must shrink also, at which time it will be found that the thin side has cooled and refuses to give way in turn, but the shrinkage will go on, and the pipe assumes a curved form, the heavy or thick side forming the concave. The above description holds good when the mould has been straight and the core placed nearer one side than the other, as in the case when a core rises in a "green sand" mould, or is set out of centre in a "dry sand" vertical mould.

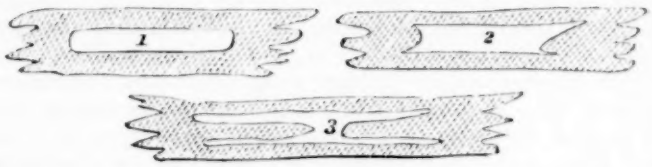
But a pipe cast as before described, does not always assume a curved form, as the moulder not unfrequently takes the advantage of turning the mould over when hot, whereby the thin or "cope" side is covered by the hot sand, while the "drag," which is thickest, is exposed to the action of the air, and thereby cools much faster than the thin side, which is protected by the hot sand, in which case the curve may be so little as to be scarcely discernible. Still the pipe remains uneven in thickness, and should it be of small diameter and thin, the bending tendency will much weaken the pipe on the thin side, and in a manner that cannot be discovered by the present manner of proving by the press, as the very means taken to procure the pressure insures its safety, for its only tendency is to a transverse fraction.

5. In clamping the moulds. This evil is not so common as the others; and when a mould is clamped thin, it is caused by carelessness or laziness. With care and judgment this evil may be avoided.

Secondly. The cause of "blows" or "blisters." The cause is not very easily described, but its appearance and characteristics I will endeavor to explain and show. A blister is simply a recess in the body of the pipe, covered by a shell inside and out, and frequently giving no sign of its presence, particularly to one not thoroughly practised

in their search. They assume all imaginable forms; some appearing under certain circumstances as follows:

Fig. 2.



And they may be found from the size of a pea, extending to several inches in length. The shell covering varies in thickness, but will commonly be from $\frac{1}{16}$th to $\frac{3}{16}$ths of an inch. In a pipe one-half inch thick, the blisters are invariably on that side of the pipe cast uppermost, commonly called the "cope," and may be found any where in the direction of its length, but generally about the middle. These blisters will occur when the core is not thoroughly dry, or when the loam is "too close," or if there be too much vegetable matter in the loam. Again, a pipe is almost sure to blister if it is poured with "dull" iron, or if it be poured slow, even with iron tolerably "sharp."

In connexion with the above, there would seem to be a fact overlooked by moulders generally, which has much to do with the difficulties which have presented themselves; it is this: "dull" iron has less specific gravity than "sharp" iron. This may be questioned, but can be easily accounted for. It is shown practically in casting pipes, and is subject of proof if necessary. The difference in weight between sharp and dull iron, is not so great as to cause the iron in a mould or ladle to assume a level just in proportion to its temperature immediately, for the reason that iron is so heavy that it requires no inconsiderable force to set it in motion, the difference in the specific gravity not being sufficient to create a rapid circulation; but should the current of circulation favor the "dull" iron, being uppermost, it will assuredly maintain that position. In order to render this more intelligible, I will endeavor to illustrate the effect by giving a description of casting a pipe which fails to run to completion. Suppose we undertake to pour a green sand pipe at the usual angle for "loam" cores, from the *bottom* of the mould: the iron which first enters through the gate will be cooled in its passage over the cold mould, and rises to give place to the hot iron following, which is continued to be displaced by the current of incoming hot iron. The iron which first entered, will be the "dullest," and consequently the lightest, and will keep uppermost as it is pressed up by the under-current of hot metal, until it finally becomes chilled and will run no further, in which case the pipes will not be run complete, which is no uncommon occurrence; but should you run the pipe from the *top* of the mould this difference is partially avoided, and only partially, for the iron falls to the bottom side of the mould as soon as it enters, and the whole current runs down the mould under the core until it reaches the lower end of the mould, or to the level of the iron in the mould, as the case may be.

It may be readily seen, from the fact of the hot iron all running down under the core, and the dull iron, being lightest, that the last will rise upon the opposite side; hence it will be seen that all the dull or chilled iron will be upon the line of the top of the pipe, and as dull iron is more favorable for the production of blisters than sharp, it becomes one of the causes of blisters in the top of pipes.

The most prolific causes of blisters are produced by a steam arising from a damp core, or the gas generating from the burning of the vegetable matter contained in the loam from which the core is made; there not being sufficient pressure in the mould at the time the gas is generated to force it through the loam to the holes in the core bar intended as its means of escape; it consequently forces itself into the iron, which it can more readily displace while the pressure of the iron is low. The specific gravity of the gas being so much less than the iron, it makes its way to the top, let it be projected from which point of the core it may, and as I have before shown, the dullest iron in the mould is on the top of the core; this dull iron sets rapidly around the gap, as in Fig. 2 (No. 1); or if the pressure is "up" before the iron sets, the gas may be compressed a little, and a portion of the iron flow back into the space, as in Fig. 2 (No. 2); or the pressure may be sufficiently strong to force a portion of the gas through the iron into the "green sand," or back again into the core, and leave a blister similar to that in Fig. 2 (No. 3). Or, as is sometimes the case, the blister will be entirely filled up, leaving the shell of the blister unmelted, in which case the shell can be knocked off, and the iron under it will show conclusively that it is a second run.

I will endeavor to explain why it is that blisters are generally found at about the centre of length of the pipe. In drying the cores in the oven, the outside of the cores is about equally exposed to the heat, but that is not so with the inside. It will be easily observed that the dampness will pass off in the form of steam much more readily from the ends of the bar than from the middle, by means of which the ends get a little more firing than the middle. This, together with the greater pressure upon the bottom of the pipe, would seem to account for the ends being more free from blisters than the middle.

Another difficulty is frequently met with by not having the cores dry, which produces a boiling of the metal upon the upper surface of the core, leaving the pipe very thin. The subjoined diagram is taken full size from a specimen of pipe six inches in diameter.

Fig. 3.

Thirdly. I will now review the causes which tend to weaken the top of a pipe cast inclined or horizontal.

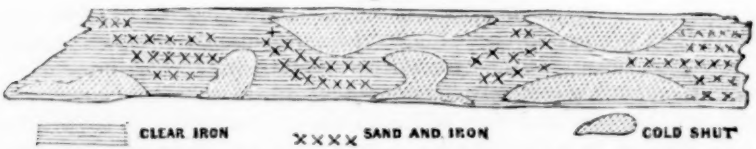
1. The unequal thickness.

I observe that every thing that tends to make a pipe uneven, does to that extent make the upper portion of it thin, and this tendency is so great that I will venture to say that if one hundred of the pipes cast under this system were broken, not one of them would be found

equal in thickness from end to end, and many of them would vary from 25 to 50 per cent. below the required thickness.

Again, into that part of the pipe which is liable to be thinnest is floated the dullest iron, and the pressure put on so slow in pouring, that the iron is liable to become set before it is pressed compactly together. The evil effects of this are shown by the liability of the pipes to be blistered and "cold shut," and all the particles of sand that wash from the mould, together with the blacking washed from the core, with whatever "slag" gets into the mould, or dirt thrown out by the iron while it is burning, is floated to the top of the pipe, causing that portion of it to become dirty, porous, and thin, with an occasional "cold shut."

Fig. 4.



The above diagram is made from a specimen taken from an 8-inch pipe. This pipe bore the pressure of 300 lbs. to the square inch, but was rejected from the discovery, at the distance of only two feet, of a place similar to the one submitted above; neither of them leaked. Now, it may be asked, how is it that with all these defects the pipes are enabled to sustain the pressure applied to them? The answer is simply this: The pipes are made of a thickness to meet the exigencies of the manufacture, and the amount added for the life of them, and for the risk attending such defects, gives a large margin in excess of what would be necessary for the required strength merely. I am required to put a pressure of 300 lbs. per square inch upon a 36-inch pipe, its thickness slightly less than an inch; and put the same amount of pressure upon a 12-inch pipe, its thickness one-half of an inch (which is very light for that diameter), yet, in proportion to its diameter, it is 50 per cent. heavier than the one 36 inches in diameter. But the latter pipe cast vertically is infinitely the safest, as is shown by inspection.

(To be Continued.)

Translated for the Journal of the Franklin Institute.

Defective Insulation by Gutta-Percha. By J. M. Gaugain.

In a former note I gave the *co-efficients of charge* of wires of small diameter, such as are employed for aerial telegraphs; and I also endeavored to determine these co-efficients for the cables which are used for sub-marine communications; but I here found an unexpected difficulty. I found that the gutta-percha which forms the outer envelope of the conducting wire possesses a very appreciable conducting power. The existence of this conduction renders it impossible to determine the *co-efficient of charge* accurately, and destroys all interest in such determination.

If the substance surrounding the conducting wire were perfectly insulating, the cable, when once plunged into the water, would form a true Leyden jar, of which the coating would be, on one side the conducting wire, and on the other the water surrounding the cable; the condensation produced by the influence of the water on the wire, would modify its *co-efficient of charge*, but the law of transmission would still be expressed by the very simple formula which I have before given, and consequently the time of propagation would remain proportional to the square of the length of the conductor.

But when the envelope of the wire possesses an appreciable conducting power, the formula which I allude to cannot be applied, and it becomes necessary to take into account the loss which is established throughout the length of the wire.

I will cite some experiments which will show the kind of absorption which the gutta-percha exerts under the circumstances of which I speak. These experiments were performed on two cylindrical condensers which differ from each other only by the nature of the substance interposed between the coatings. One of the two is only an end of a telegraphic cable formed by a copper wire and an envelope of gutta-percha; in the other, the gutta-percha has been replaced by gum-lac. In both, the exterior coating is made of a thin sheet of tin, applied upon the surface of the insulating envelope. The thickness of this envelope is 5 mm. (0·2 in.), the diameter of the wire is 1 mm. (0·04 in.), the length of each condenser is about 50 centim. (20 in.) The following are the results which I got in comparing these two apparatus:

1. When the gum-lac condenser was charged by putting the interior wire into communication with the source, and the external coating in communication with the ground, the charge which either coating takes is nearly independent of the time during which the condenser remains in contact with the source. *It is altogether different with the gutta-percha condenser; the charge which this apparatus receives varies, and very notably, according to the time during which it is left in communication with the source. It requires more than a quarter of an hour to saturate the apparatus*, and the maximum charge may be double or triple that which is obtained when the communication is established but for a few seconds.

The maximum charge of the gutta-percha condenser is, however, greater than that which the gum-lac condenser takes under the same conditions.

2. When the gum-lac condenser has been charged, and a metallic communication is established between its coatings, the maintenance of this communication for a few seconds is sufficient to discharge the apparatus completely. When, on the contrary, it is desired to discharge completely the gutta-percha condenser after saturation, it will be found necessary to maintain the communication for more than a quarter of an hour.

It evidently results from these observations that gutta-percha possesses considerable conducting power, which allows it slowly to absorb the electricity and to return it. I have before observed that this pro-

perty differs in different specimens, and I will here add, that in the same specimen it also changes very notably with the temperature.

It appears to me certain, that this kind of absorption of which I have spoken, is produced in submerged telegraphic cables, as well as in the condensers upon which I experimented, and it will easily be conceived that it is injurious. In fact, when the circuit is closed at one station, the wire must first be charged more or less completely, before the current can act on the receiving apparatus, and consequently the absorption must retard the transmission of signals. Again, when the circuit is opened, the gutta-percha, which is, so to speak, saturated with electricity, restores it, and the receiver continues to receive a current after the transmitting station has ceased to send one. These inconveniences will be felt more severely in proportion as the wires in operation are larger, and I think that we ought to endeavor to avoid them. We will succeed by applying upon the wire a coating of very insulating varnish to separate it from the gutta-percha. The whole difficulty consists in finding a varnish which will insulate sufficiently. The different varnishes may be very easily tried by the experimental process which I have used.—*Cosmos*, February, 1861.

Translated for the Journal of the Franklin Institute.

Explosion of a Steam Boiler.

M. Jobard has given to the Academy of Sciences at Paris, the following account of an explosion which took place at Mæstrich, by which the proprietor and engineer, who had taken advantage of the stoppage of the works for the purpose of taking the measures inside of the furnace for a new grate, were killed.

"When the workmen go to dinner, the fireman covers the grate with the siftings, closes the register of the chimney and the furnace door, and often places a plate of sheet-iron before the opening of the ash-pan, for the purpose of preserving his fire by stopping the draft. At the first sound of the recall-bell, the fireman ought at once to open the chimney-register, so as to discharge the gases which have been produced in this sort of retort; the air of the ash-pan soon becomes filled with the hydrogen gas which fills the furnace, flues, and every part accessible to flames. This mixture of air and hydrogen constitutes a kind of *fire-damp* perhaps even more dangerous than that of the mines, because it is heated.

"The engineer must have neglected to discharge this gas before opening the furnace-door, with a lamp in his hand; hence the explosion which lifted up the boiler, and burst it at its weakest part.

"I have every reason to believe that the greater part of the explosions have a similar cause to that which I have suggested; for almost all the accounts in the Journals begin with these characteristic words, 'At the moment when they were about to recommence work in the establishment of X———, a terrible explosion was heard; happily the workmen had not yet returned.'

"Who does not see that at the first blow of the bell, the fireman

begins to rake his fire, so as to start the engine, forgetting first to open the chimney: a precaution which he thinks unimportant because he has freqently neglected it without becoming a victim, for the mixture is not always in explosive proportions. The narrative does not fail to add, that the boiler was lifted from its seat, which would not happen if the explosion had not taken place in the furnace; the second explosion, which is confounded with the first, is that of the boiler itself, brought about by the shock of the first." *Comptes Rendus*, 4th Feb. 1861.

M. Jobard is a man of experience and ingenuity, and we call attention to this account, because the custom which he explains is a dangerous one, and the precautions which he indicates are very proper and even necessary. But we differ from him entirely as to his supposition that this is the general explanation to be given of explosions which happen when starting a steam engine. In the first place, these frequently occur under circumstances where such an explanation is inadmissible, and are clearly due to the fact that, the water has gradually been evaporating from the boiler during the rest of the machine, and none has been supplied; and secondly, we do not understand how under ordinary arrangements, an explosive mixture can leak from the top of the furnace into the ash-pan, through a bed of hot coals, without burning, and this would consume all the explosive mixture, as it was generated. As to the throwing 'the boiler from its seat,' this is easily explained by the reaction of the steam issuing into the furnace, and against the bottom of the ash-pan, and takes place whenever the fracture takes place in the lower part of the boiler. Ed.

A Constant Copper-Carbon Battery.—By Julius Thomsen.

From the Lond. Ed. and Dub. Phil. Mag., January, 1861.

In the ordinary galvanic apparatus, zinc usually officiates as positive element. This metal is, however, readily attacked by acid if it is not either chemically pure or well amalgamated. If the sulphuric acid is not greatly diluted, the zinc cylinders are strongly attacked by continuous use, in spite of the amalgamation, by which a great loss of metal is caused; if on the other hand, the acid is much diluted, it is soon saturated, and the action of the apparatus is enfeebled.

In my investigations I use a galvanic apparatus consisting of *copper* in dilute sulphuric acid (1 part acid and 4 parts water) as positive element, and, as a negative element, *carbon* in the mixture of bichromate of potass, sulphuric acid, and water, recommended by Wöhler and Buff. (Buff uses 100 parts of water, 12 of bichromate, and 25 of sulphuric acid.) The electromotive force of this combination is $\frac{9}{10}$ths of that of a Daniell's battery.

Its advantages are as follows:—The copper is not at all attacked by the acid when the circuit is open; the resistance of the sulphuric acid, from its being so little diluted, is a minimum: the sulphuric acid is so strong that it can be used for months without becoming saturated. As, further, the mixture of chromate of potass and sulphuric acid is in-

odorous, this combination is very convenient for working with in closed spaces.

This combination is very interesting theoretically; for as copper cannot decompose dilute sulphuric acid, the copper-carbon element is an example of a powerful apparatus in which chemical action and the disengagement of electricity are quite inseparable.—Poggendorff's *Annalen*, October 5, 1860.

On a New Purple and on a Blue Dye, Soluble in Alcohol.

By C. Greville Williams.

From the Lond. Chemical News, No. 46.

Chemists familiar with dyes and pigments are aware that great efforts have lately been made to form purples by the addition of a blue to the new red colors known as magenta, fuchsine, &c. A certain amount of success has been obtained by printing carmine of indigo along with magenta red upon woolen fabrics. But this process has of necessity received a very limited application, owing to the impossibility of rendering the indigo soluble in the same menstruum as the magenta. In fact there is no blue dye or pigment soluble in alcohol known to technical chemists. Such a substance, which has been for some time vainly sought, I have at last succeeded in obtaining in large quantities from cinchonine, or rather from the chinoline which is procured by distilling the former alkaloid with caustic soda or potash. The process is, in its main features, the same as that by which I demonstrated a specific difference to exist between the chinoline from coal tar and that obtained by the process just alluded to.* I have however greatly improved the process, so as to reduce its cost to a minimum, and bring it within the reach of commercial enterprise. Cinchonine being a waste product, has in some quinine manufactories accumulated to the extent of tons, and so long as its price does not exceed 8*s*. or 10*s*. per lb it can with profit be employed in producing blue and purple dyes.

The quantity of crude chinoline yielded is much greater than is generally supposed, and moreover the amount of dye procurable is very great. This arises from the fact that in addition to chinoline, amyle enters into the compound, and we thus take advantage of its high atomic weight.† It might be urged that iodide of amyle is far too expensive a reagent to be employed with success in any commercial operation. To this it may be answered that fusel oil is procurable for 1*s*. 6*d*. per gallon, and iodine can now be purchased in quantity for 8*s*. and phosphorus for 2*s*. 6*d*. or 3*s*. per pound. If, therefore, a plan could be devised by which the iodine might be recovered, the entire process would acquire a practical character. Now the recovery of the iodine is easy if we follow the second method of preparation given below; moreover the sulphate and chloride of amyle will probably ere long be substituted for the comparatively costly iodine.

In order to procure the blue color, one part by weight of chinoline

* On Isomeric Alkaloids, Chemical News, vol. i. p. 15.

† $C_{10}H_{11} = 71$.

is to be boiled for ten minutes with one and a half parts of iodide of amyle. The mixture from being straw-colored becomes deep reddish brown, and solidifies on cooling to a mass of crystals. This product of the reaction is to be boiled for ten minutes with about six parts of water, and, when dissolved, filtered through paper. The filtered liquid is to be gently boiled in an enamelled iron pan over a small fire, and excess of ammonia gradually added. The ebullition may be prolonged with advantage for one hour, the evaporation of the liquid being compensated for by the gradual addition of weak solution of ammonia. The latter may be prepared by the admixture of equal volumes of ammonia of the density 0·880 and distilled water. The hour having elapsed the whole is allowed to cool, when the color will almost entirely have precipitated, leaving the supernatant liquid nearly colorless. On pouring the fluid away (preferably through a filter, in order to retain floating particles of color), the dish will be found to contain resinous looking masses which dissolve readily in alcohol, yielding a rich purplish-blue solution which may be filtered and kept for use.

The color prepared as above is, as has been said, of a purplish tint, but, if a purer blue be required the following modification is to be resorted to. The filtered aqueous solution of hydriodate of amyle-chinoline, is, as before, to be brought to the boiling temperature, but instead of adding ammonia, a solution of caustic potash containing about one-fifth of its weight of solid potash is to be substituted. The addition is to be continued at intervals until three-fourths as much potash has been added as is equivalent to the iodine in the iodide of amyle used. The fluid may, after a quarter of an hour's ebullition, be filtered to separate the resinous color. The product is a gorgeous blue with scarcely any shade of red. On adding the other fourth of potash to the filtrate while gently boiling, a black mass will be precipitated containing all the red, which otherwise would have been mixed with the blue. This mass dissolves readily in alcohol, yielding a rich purple solution, containing, however, an excess of red. The alcoholic solution on filtration leaves on the filter a dark mass soluble in benzole, and as sometimes prepared, affording a brilliant emerald green solution of great beauty. It is not always easy to obtain this green color. I have never on any occasion, however, seen a failure in preparing the blue or purple.

With regard to the economy of the process, the following is a near approximation to the produce in my later experiments. Cinchonine, distilled with excess of caustic soda, affords 65 per cent. of crude chinoline, containing in addition to that base lepidine, cryptidine, and at least two more as yet unknown homologues of chinoline, besides pyrrol and a number of bases isomeric with the pyridine series. The water that comes over in the distillation contains ammonia, and the more soluble of the latter class. All the distillate which on rectification distils above 390° or 408° Fahr. up to the highest range of the mercurial thermometer, is suitable for preparing the color.

One part of the mixture of bases above alluded to, and one and a

half parts of iodide of amyle, yield 23 parts of blue dye containing four per cent. of solid coloring matter. One volume of magenta pink, of the ordinary strength found in commerce, and two volumes of the chinoline blue, form a fine purple inclining to the blue shade. The proportion of magenta may, in many cases, be increased with advantage. The color on wool or silk stands soap well.

To the Editor of the Journal of the Franklin Institute.

NEW YORK, Wednesday, April 17th, 1861.

SIR:—Having observed in a late number of the *Journal* an item in relation to the speed of vessels, I thought the enclosed might prove acceptable. They can be relied upon as correct.

I am, very respectfully, your obedient servant.

EDWARD BRANDT.

—

Remarkable Speed.

STEAMSHIP PERSIA.—This vessel sailed from Liverpool at noon March 30th, and from Queenstown on the evening of the 31st, arriving in New York April 9th, making the shortest passage across the Atlantic Ocean on record. The subjoined is a copy of her log:—

DATE.	Winds.	Course.	Distances.	Latitude.	Longitude.
March 30,	—	—	—	—	—
" 31,	N. E.	Various.	240	—	—
April 1,	Easterly,	W. N. W.	172	51·13	14·12
" 2,	—	—	313	50·38	22·10
" 3,	S. E.	W. by N.	329	49·01	30·31
" 4,	E. N. E.	—	334	47·50	38·24
" 5,	N. E.	W. by N.	338	45·19	45·57
" 6,	N. N. E.	—	350	43·43	53·48
" 7,	N. by E.	W. ½ N.	331	42·27	61·20
" 8,	North,	—	326	40·50	68·04
" 9,	"	—	292	—	—

Remarks.—March 30.—11·30 A. M. received mails; 12 M. left Liverpool; 1·05 P. M. discharged pilot.

March 31.—Moderate and fine; 9·30 A. M. passed Roches' Point; 9·40, Queenstown; 4·05 P. M. received mails; 4·43 P. M. left Queenstown.

April 1.—Moderate and clear; 8·30 P. M. passed Steamship *Niagara*, bound east.

April 2.—Light winds and fine weather.

April 3.—Moderate, cloudy weather.

April 4.—Moderate, fine, clear weather.

April 5.—Fresh breeze, thick fog.

April 6.—Strong gale, high sea.

April 7.—Fresh gale, snow squalls.

April 8.—Moderate breeze.

April 9.—Strong breeze; 5·47 A. M. received pilot; 6·50 A. M. at Sandy Hook; 7·30 A. M. Staten Island; 8·10 A. M. New York.

FRIGATE ISIS.—A remarkable instance of fast sailing has been recorded of this vessel, which returned into the harbor of Brest on the 16th of November last, after two incredibly rapid voyages. She left that port for Papahiti on the 19th of April, 1860, and reached her destination on the 4th of August, making the run in 107 days. Starting again on the 19th of the same month, she arrived at Brest after a voyage of 89 days, without having seen land, or putting into any harbor; thus going 10,000 leagues (more than the distance around the world), in the space of 196 days, and having been only six months and twenty-eight days at sea from her first departure. This prodigious rapidity exceeds the rate of sailing of some of the fleetest ships, as for instance, that of the *Sovereign of the Seas*, mentioned by Lieutenant Maury, U. S. N., as unique for her sailing powers, and also the voyage round the world of the *Swordfish*, performed in ten months and ten days, and equally cited by him as a remarkable trial of speed. The frigate *Isis* was equally fortunate in the healthy state of her crew and passengers, not a single case of illness or death having occurred during the entire voyage.

CLIPPER BARK DAWN.—The shortest passage ever made from Buenos Ayres to New York (or any other American port), was accomplished in the summer of 1860 by this bark. It was made in 36 days, from May 5th to June 12th, and as the distance is 6500 miles, it will be seen she averaged over 180½ miles per day. Her previous passage was made in 39 days from the same port. The *Dawn* was built in New York in 1857 by Thomas Collyer, Esq., and under the command of Captain Chase, all her voyages on an average are without a parallel.

CLIPPER SHIP ANDREW JACKSON.—This renowned ship arrived in the port of New York on the morning of the 20th of November last from Liverpool in 15 days passage, with a full cargo. She also made the voyage to Liverpool, laden with grain, in 15 days, and on the voyage out and home was only 30 days at sea, including 2 days of very calm weather. During this time she sailed over 6500 miles, thus averaging nearly 220 miles per day throughout—a rate of speed rarely if ever equalled, continuously, in a sailing vessel before or since. The *Andrew Jackson* was built by Messrs. C. H. Mallory & Co., of Mystic, Conn.

BARK PALLAS.—This bark, commanded by Captain Biddle, from New York, February 21st last, arrived at Balize, Honduras, after the extraordinary run of eleven days. The *Pallas* was built, and is at present owned in New York. E. B.

Translated for the Journal of the Franklin Institute.

A New Lubric and Varnish.—Heveone.

At a recent meeting of the Academy of Sciences at Paris, M. Matthieu, a maker of surgical instruments, presented a vegetable fat, at the same time viscous and elastic, to which he had given the name of

Heveone, for the purpose of recalling at the same time, first, that its principal element is the essence of caoutchouc, or caoutchouc highly purified, prepared from *Hevæa Guyanensis;* second, that it is prepared at a very high temperature.

This new preparation possesses very remarkable properties, and will be of very great service to many branches of industry. It adheres considerably to the surfaces to which it is applied; does not oxidize under the influence of atmospheric agents; and preserves from rust, instruments of iron, steel, copper, or any other polished metal, even when spread over them in an infinitely thin coating. Surgical and domestic instruments, tools and machinery, hunting and other weapons, may be kept perfectly clean and bright.

The lubricating properties of *Heveone* are still more extraordinary; applied to stop-cocks, pistons, valves, pivots, axles, locks, hinges, &c., it makes them play the more easily, inasmuch as it never dries, does not lose its viscosity, does not oxidize, nor combine with the metals.

Heveone, besides, as a coating impermeable to water, will do much to keep clean and in good order, leather, and objects formed of leather, such as shoes, harness, belts, &c.; it will protect them both from damp and from too great dryness; it makes them very pliable, and renders them imperishable; its salutary effects will extend even to wood, pedestals, panels, wainscoating, &c. We will relate one more very precious property of *Heveone*. In fire-arms coated interiorly with it, there no longer forms any adhesive dust in firing; they will be much more easily cleaned, and when fired frequently in succession, the aim will remain more certain and the range greater.—*Cosmos.*

Translated for the Journal of the Franklin Institute.

A new Stereoscope without Lenses.

In the *Nuovo Lincei*, M. Volpicelli describes a new stereoscope presented by him in April, 1854. This very simple stereoscope without mirrors or lenses, consists of a rectangular horizontal box, whose proportions are as follows: height 11 centim. (4·5 ins.); depth 20 centim. (8 ins.); length 62 centim. (24·8 ins.) The two stereoscopic pictures are placed against the back of the box; in the front of the box two holes are bored opposite the middle of the pictures. Two diaphragms made of plates of blackened wood or card-board, of the height of the pictures, are made to rotate around vertical axes corresponding to the front edges; and are so adjusted that they allow the right eye to see only the left picture, and the left eye the right picture. It follows that the rays by which the pictures are seen cross each other within a certain space in the middle of the box, and in this space, after a little effort, the eyes see the object in relief.

If after the relief is seen the diaphragms are turned around their axes, so as to rest against the sides of the box, and no longer intercept the view—the eyes still continuing to view the picture in relief—a very interesting physiological phenomenon will be seen. There will be seen three pictures—one in the middle of the instrument, in relief,

the others alongside, and by no effort of will can the middle picture be made to disappear.

If the pictures be of complementary colors, they will be seen of their own colors, and the relief will be white.

Those who are not accustomed to observation of optical phenomena will require some attention to see the relief at first, but it will generally be found by looking attentively at about the middle of the box. When once seen it may be recovered without any difficulty.

Cosmos, September, 1860.

Translated for the Journal of the Franklin Institute.

Preparation of Oxygen from Sulphuric Acid.

The acid of the chambers, or still better that concentrated to 61°, will serve excellently for the very easy preparation of oxygen, since at a feeble red heat it is completely transformed into a mixture of water, sulphurous acid, and water.

A retort of 5 quarts filled with platinum foil, or still better, a platina worm filled with platina sponge is brought to a red-heat. A small stream of the sulphuric acid passing through an S tube and running steadily is introduced; the gases which are produced pass first through a refrigerator to separate the water, and then through a peculiar washer. There escapes oxygen gas pure and without smell, and a concentrated solution of sulphurous acid.—*Cosmos*, November, 1860.

Artificial Leather.

From the London Builder, No. 932.

We lately took occasion to allude to endeavors to realize an idea suggested in the *Builder* on this subject; and we now extract the following remarks, in a condensed form, as to a farther step in progress, from the *Suffolk Chronicle*:—"To Ipswich belongs the honor of an invention to gather up vast heaps of rubbish in the shape of leather cuttings, parings, and shavings; and by a peculiar process, partly chemical and partly mechanical, to reduce them to a pulpy mass, and mould them to any desired form for useful and ornamental purposes. A factory is now erected, and a company formed, bearing the name of the 'Patent Plastique Leather Company.' The goods manufactured are more durable, and 20 to 30 per cent. cheaper than all other leather goods. We have made inquiry into this new process, and find the leather may be made as pliant as india rubber, or as hard as board, and becomes adapted to an endless variety of uses, as bands for machinery, buckets for pumps (having all the suction of leather, with ten-fold durability), and rubber for pencil marks. It is eminently adapted for all kinds of architectural ornamentation, in-door or out, and is an excellent material for picture frames, plain or gilded, not being liable to cast or break. It can be made of any color, matching the grain of all dark wood so accurately that even a skilful workman would mistake it for carving. This most truly useful invention, we have no doubt, under the hand of its originator, Mr. R. Seager, will ere long, take its rank among our staple manufactures.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM FEBRUARY 1, TO FEBRUARY 28, 1861.

Anvils,	C. H. Schadt,	City of	N. Y.	12
Apples,—Mills for Grinding	Leander McKee,	Hagerstown,	Md.	26
Artesian Wells,—Tubes of	H. W. Spooner,	Erie,	Penna.	26
Barrels,—Making	Sheridan Roberts,	Cleveland,	Ohio,	26
Bee-hives,	S. R. Bryant,	Waterford,	Penna.	12
———	J. C. Gray,	Frankfort,	Ind.	19
———	Hartley & Morehouse,	Quincy,	Ill.	12
Blotters,—Roll	P. B. Sheldon,	Prattsburgh,	N. Y.	19
Boot Jack,	H. N. DeGraw,	Green Island,	"	12
Boots & Shoes,—Heel Attachm't	G. C. Aiken,	Worcester,	Mass.	5
Brakes,—Car	A. C. Herron,	West Farms,	N. Y.	12
———,—Railroad	Daniel Derr,	Bellefonte,	Penna.	26
Bran Dusters,	Clark & Elting,	Sandusky,	Ohio,	12
Bridges,—Truss	E. J. Story,	Getyville,	N. Y.	12
Bridle Bits,	J. M. Roberds,	Washington,	D. C.	26
Broom,	Daniel Kaufman,	Boiling Spring,	Penna.	19
Brush Blocks,—Boring	Thomas Mitchell,	Lansinburgh,	N. Y.	19
Butter Worker,	J. A. Allen,	Deerfield,	Mass.	12
Car Wheels,	W. W. Snow,	Jersey City,	N. J.	19
Card Teeth of Carding Cylinders,	Charles Hardy,	Biddeford,	Me.	5
Carding Machines,	Joseph Davis,	East Wilton,	N. H.	12
Carpet Stretcher,	Greenleaf & Buckland,	Springfield,	Mass.	12
——— Tack Driver,	H. S. Walcott,	East Boston,	"	5
Carriage Work,—Collar for	Moses Seward,	New Haven,	Conn.	5
Cart,	N. R. Baldwin,	Afton,	N. Y.	5
Cheese Vats,—Heater for	Howell Cooper,	Watertown,	"	12
Chronometer Escapement,	Prosper Humbert,	Boston,	Mass.	26
Churn,	Peter Dunwald,	Corning,	N. Y.	19
———	M. C. Longacre,	Cleveland,	Ohio,	5
———	J. R. Mickey,	Waterford,	Penna.	26
———	J. V. Stevens,	Pomeroy,	Ohio,	5
———	V. Stirewatt,	Albany,	N. Y.	12
Cider Mills,	H. T. Watkins,	Anderson,	Ind.	5
Cigar Machines,	W. W. Huse,	Brooklyn,	N. Y.	12
———	Muller & Majer,	City of	"	19
Clothes Frame,	L. F. Frazee,	Tottenville,	N. Y.	26
Clover Seed,—Hull'g & Clean'g	D. S. Wagener,	Penn Yan,	"	12
———,—Separating	Henry Hunsiker,	Lewisburgh,	Penna.	12
Coal,—Breaking	L. P. Garner,	Ashland,	"	19
———	R. A. Wilder,	Cressona,	"	19
Coal Sifter and Shovel,	A. H. Knapp,	Newton Centre,	Mass.	26
Coffins,—Metallic	J. H. Renshaw,	Knoxville,	Tenn.	12
Cord,—Guides for Laying	Wm. Taylor,	Berlin,	N. Y.	19
Corn Planters,	B. H. Elmore,	Richmond,	Ind.	19
———	L. K. Jenne,	Grand Rapids,	Mich.	12
———	F. B. Preston,	Fayette,	Mo.	26
Cotton & Corn Stalks,—Extract.	Josiah Bishop,	Austin,	Texas,	19
——— Bales,—Tighten'g Ropes	Charles Wilson,	Brooklyn,	N. Y.	19
——— Cleaners,	E. A. Hearne,	Lowndes co.,	Ala.	19
——— Gins,	J. B. Peyton,	Raymond,	Miss.	5
——— Scrapers,	Josiah Shephard,	Columbia,	Texas,	19
Coupling Links of Railroad Cars,	Tyler Andrews,	North Easton,	Mass.	5
Cow-bells,	G. C. Albaugh,	Louisville,	Ky.	26
Cultivators,	Beach & Brown,	Jacksontown,	Ohio,	12
———	Solomon Dwight,	Byron,	Ill.	5
———	S. M. Goff,	East Addison,	Vt.	12

Cultivators,	Leeper & Kidder,	San Jose,	Ill.	12
———	Whitman Price,	Mount Olive,	N. C.	12
———	J. W. Taylor,	Ashland,	Va.	12
———,—Rotary	Cicero Comstock,	Milwaukie,	Wis.	26
———,—Seeding	C. T. Settle,	San Jose,	Cal.	26
Curtain Fixture,	J. Y. Marsh,	City of	N. Y.	26
Ditching Machines,	Doolittle & Eldridge,	Dansville,	N. Y.	12
———	C. E. Martin,	Muscatine,	Iowa,	26
Dove-tailing Machine,	Eleazer Coffin,	Indianapolis,	Ind.	5
Drawing-heads,—Stop Motion for	B. O. Paige,	Lowell,	Mass.	12
Drill,—Rock	Wm. Harson,	City of	N. Y.	12
Drying Tunnel,	F. H. Smith,	Baltimore,	Md.	26
Earth-boring Machine,	Manley & Wedge,	Zanesville,	Ohio,	19
Eave Troughs & Piping,—wood	S. T. Field,	Worcester,	Mass.	19
Electric Currents,—Integrating	Chas. Kirchhof,	City of	N. Y.	26
Fares on Conveyances,—Ascert.	D. F. Haasz,	Philadelphia,	Penna.	19
Felloe Machine,	C. H. Denison,	Brattleboro',	Vt.	19
Files and Rasps,—Manufacture of	Thomas Sheehan,	Dunkirk,	N. Y.	5
Filters,	L. P. Jenks,	Boston,	Mass.	5
Fire Arms,	Daniel Moore,	Brooklyn,	N. Y.	19
Fish Hooks,	W. S. Morris,	City of	"	12
Flat Irons,—Guard to	J. C. Briggs,	Concord,	N. H.	5
Flock,—Sifting	J. F. Greene,	Brooklyn,	N. Y.	26
Flower Pots,	Otto Eberhardt,	"	"	5
Fluid Compositions,—Burning,	B. F. Hebard,	Neponset,	Mass.	19
Fracture Apparatuses,	John Whitten,	Boston,	"	19
Fruit Gatherers,	Byrn & Clark,	City of	N. Y.	26
———	L. M. Parker,	Shirley Village,	Mass.	19
Furnaces for Treating Iron Ores,	Isaac Rogers,	Haverstraw,	N. Y.	26
———,—Fires of Reverberat.	Jacob Reese,	Pittsburgh,	Penna.	5
Furniture Castor,	Edward Lindner,	City of	N. Y.	26
Gas Burners,	Morson & Moore,	New Haven,	Conn.	19
—— Burner Regulators,	A. H. Wood,	Boston,	Mass.	19
—— Cocks,	J. G. Leffingwell,	Newark,	N. J.	19
——,—Lighting	S. B. H. Vance,	City of	N. Y.	5
——,——— and Extinguish.	N. S. Manross,	Forrestville,	Conn.	5
Gates,	Hiram Barber,	Milpitas,	Cal.	19
Globes,—Moulded Elastic	H. B. Goodyear,	New Haven,	Conn.	5
Grain Binding Machines,	W. W. Burson,	Yates City,	Ill.	26
———	Stephen Reynolds,	Richmond,	R. I.	12
——— Measurer and Register,	J. A. Cluxton,	Bentonville,	Ohio,	26
——— Separators,	James Matthews,	Middletown,	Penna.	26
———	Jefferson Nash,	Janesville,	Wis.	12
Grainers Tools,	R. A. Adams,	Indianapolis,	Ind.	12
Gridirons,	Shavor & Corse,	Troy,	N. Y.	19
Guano Spreaders,	I. J. Saunders,	Sparta,	Ga.	12
Harrows,—Rotary	L. S. Tyler,	Linesville,	Penna.	5
Harvesters,	P. H. Standish,	Pacheco,	Cal.	19
———	J. B. Smith,	Winfield,	N. Y.	19
———	J. B. Tinker,	Plymouth,	"	5
———,—Binding Attachmt.	S. P. Harris,	Mansfield,	Ohio,	26
———,—Cane	W. B. Robertson,	W. Bat. Rouge,	La.	12
———,—Rakes for	T. S. Whitenack,	Easton,	Penna.	5
Harvesting Machines,	Rufus Dutton,	Dayton,	Ohio,	12
Hat Blocks,	W. W. Cumberland,	Newark,	N. J.	19
Hay,—Loading	J. B. McIntosh,	Girard,	Penna.	19
——,—Raking and Cocking	L. R. Stone,	Owassa,	Mich.	26
Hemp Brakes,	Robert Dodsworth,	St. Louis,	Mo.	12
Hoe Blanks,—Manufacture of	Nathan Brand,	Leonardsville,	N. Y.	26

Horse-Powers,	T. J. Bottoms,	Thomasville,	Ga.	5
———	J. S. Upton,	Battle Creek,	Mich.	5
——— Shoe,	Ebenezer Cate,	Franklin,	N. H.	5
Hose Tubing,—Caoutchouc	T. J. Mayall,	Roxbury,	Mass.	26
Hot Air Register,	J. H. Simonds,	City of	N. Y.	19
Hydrants,	J. P. Kenyon,	Brooklyn,	"	19
Ice Chair,	Frederick Ashley,	City of	N. Y.	5
—- Cream Freezers,	E. P. Torrey,	"	"	19
—,—Apparatus for Cutting	J. Fielemeyer,	Philadelphia,	Penna.	5
India Rubber Goods,—Manuf. of	Hiram Hutchison,	Newark,	N. J.	12
Iron Bars and Rods,—Polishing	Bernard Lauth,	Pittsburgh,	Penna.	26
——,—Tools used in Manufac.	A. L. Fleury,	Philadelphia,	"	19
Journal Boxes,	N. W. Clark,	Clarkston,	Mich.	5
Knife Sharpener,	J W Hyatt, Jr., & I S Hyatt,	Chicago,	Ill.	19
Knitting Machines,	J. B. Aiken,	City of	N. Y.	5
———	M. L. Roberts,	Mt. Union,	Ohio,	12
Lamps,	C. W. Cahoon,	Portland,	Me.	19
———	W. H. Topham,	New Bedford,	Mass.	19
Leather,—Tanning	Phylander Daniels,	Le Roy,	N. Y.	5
———,—Water-proofing	Goldenblum & Steiner,	E. Hampton,	Mass.	19
Legs,—Artificial	Douglas Bly,	Rochester,	N. Y.	19
Life Boat,	J. T. Scholl,	Port Wash't'n,	Wis.	26
Life-preserving Ship,	Theodore Burr,	Battle Creek,	Mich.	12
Lime Kilns,	Richard Donaldson,	Mount Nebo,	Penna.	19
Lock Attachment,	P. P. Stephan,	Newark,	N. J.	5
—— for Railway Cars,	Thomas Slaight,	"	"	5
Locks,	F. G. Johnson,	Brooklyn,	N. Y.	5
———,—Hoop	Charles Hughes,	New Orleans,	La.	5
———,—Nosings for	J. L. Rowe,	City of	N. Y.	5
Looms,	Wm. Murkland,	Lowell,	Mass.	5
Lubricating Compound,	Wm. Turner,	Phœnixville,	Penna.	19
Lumber,—Measuring	Charles Fleming,	Ypsilanti,	Mich.	5
Masons Trowels,	Franklin Bisbee,	Scituate,	Mass.	19
Mills,	Wm. Stewart,	Philadelphia,	Penna.	19
Motion,—Transmitting	Samuel Andress,	Chesaming,	Mich.	26
Mowing Machines,	T. H. Dodge,	Washington,	D. C.	19
Nail Machine,	Alfred Owen,	Buffalo,	N. Y.	12
Newspaper Wrappers,	L. P. Mara,	City of	"	19
Ordnance,	B. T. Babbitt,	City of	N. Y.	5
Ores of Precious Metals,—Treat.	Wethered & Woodworth,	San Francisco,	Cal.	19
Packing Case,	H. D. Stover,	City of	N. Y.	26
Paper Cutter & Rule,—Combin.	T. E. Oliver,	"	"	26
———,—Folding	W. H. and J. Milliken,	Manchester,	"	26
——— Pulp,—Mills for Grinding	Joseph Jordan, Jr.,	E. Hartford,	Conn.	5
———————	Gelston Sanford,	City of	N. Y.	12
Pendulums,—Compensating	Lewis Bradley,	Hartford,	Conn.	26
Pens,—Fountain	P. C. Clark,	Reading,	Penna.	5
———,—Guides for	I. H. Hobbs,	Philadelphia,	"	19
Photographs by Artificial Light,	P. F. & W. S. Dodge,	W. Cambridge,	Mass.	19
———,—Toning	Rufus Anson,	City of	N. Y.	19
Piano-forte Action,	I. I. Harwood,	Boston,	Mass.	12
Piston and Piston Valves of S.E.,	T. S. Davis,	Jersey City,	N. J.	5
Planers,—Feeding Rotary	P. H. Woolsey,	Andes,	N. Y.	19
Ploughs,	J. K. Gingrich,	N. Annville,	Penna.	19
———	D. H. Maloy,	Temperance,	Ga.	26
———	J. M. Rodman,	South Union,	Ky.	26
———	H. D. Rogers,	Grafton,	Ohio,	12

Ploughs,	Gabriel Utley,	Chapel Hill,	N. C.	12
———	George and John Seibert,	Ashley,	Ill.	26
———	W. F. Shedd,	Ripley,	Ohio,	26
———,—Capstans for	H. C. Drew,	Stockbridge,	Mich.	19
———,—Ditching	Ferdinand Pimmer,	Grand Junction,	Tenn.	12
———,—Mole	Hammer & Gordon,	Lisbon,	Iowa,	5
———	M. A. Howell, Jr.,	Ottawa,	Ill.	5
———,—Snow	Cassaday & Clark,	Buffalo,	N. Y.	26
———	F. J. Steinhauser,	Lancaster,	Penna.	19
Potatoes,—Machines for Digging	Clint & Lynd,	Poestenkill,	N. Y.	5
Pottery,—Machines for Moulding	Wm. Linton,	Baltimore,	Md.	12
Presses,	Enoch Thomas,	Beverly,	Va.	19
———,—Cotton	A. Z. McBride,	Hannahatchee,	Ga.	5
———,—Printing	George and S. P. Gary,	Oshkosh,	Wis.	26
Printers Rules,—Mitering	G. H. Babcock,	City of	N. Y.	5
Pumps,	Thomas Hansbrow,	Sacramento,	Cal.	5
Punching Machine,	Hiram Powers,	Florence,	Italy,	19
Quartz Crushers,—Stamp Head	Thomas Wise,	Boston,	Mass.	26
Radiators,	J. R. Supplee,	Bridgeport,	Penna.	19
Railroad Car Wheels,	G. G. Lobdell,	Wilmington,	Del.	19
——— Tickets,—Numbering	G. J. Hill,	Buffalo,	N. Y.	5
Rake Heads,	J. C. Stoddard,	Worcester,	Mass.	12
Rakes,—Horse	D. B. Woodward,	Ercildoun,	Penna.	19
Reaping and Mowing Machines,	Salem Copeland,	Worcester,	Mass.	19
Rocking Horse,	J. A. Crandall,	City of	N. Y.	5
Roofing for Slate,	J. S. Sammons,	"	"	26
Saccharine Juices,—Evaporating	M. H. Mansfield,	Ashland,	Ohio,	12
——— Liquids,—Defecating	Jules Duval,	New Orleans,	La.	5
Salt,—Manufacture of	N. W. Clark,	Clarkston,	Mich.	12
Sausage Stuffer,	Martin Riling,	Altoona,	Penna.	12
Saws to Arbors,—Secur. Circular	John Andrews,	Brunswick,	Me.	26
——,—Secur. Reciprocating Mill	J. H. Tutman,	Plattsburgh,	N. Y.	19
Sawing Machines,—Cross-cut	Peter Fischer,	Fort Adams,	Miss.	26
———	Daniel Foreman,	Navarre,	Ohio,	26
Scale Beams,	A. B. Davis,	Philadelphia,	Penna.	26
Screw Blanks,—Feeding	D. M. Robertson,	Manchester,	N. H.	12
Seeding Machines,	J. M. Bacon,	Ripon,	Wis.	19
———	Nelson Ford,	Cambridge,	"	26
———	C. W. Fossler,	Freeport,	Ill.	12
———	T. B. Jones,	Earlville,	"	12
Seed Planters,	C. C. Garrett,	Spring Hill,	Ala.	12
———	Stephen Johnson,	Cold Springs,	N. Y.	5
Sewing Machines,	Louis Ballman,	Boston,	Mass.	19
———	A. H. Hook,	City of	N. Y.	5
———	Francis Nivelle,	Paris,	France,	5
———	Quartus Rice,	W. Winstead,	Conn.	12
———	J. M. Smith,	Somers,	N. Y.	5
———	L. H. Smith,	Salem,	"	12
———	C. W. Williams,	Boston,	Mass.	12
———,—Brakes for	Daniel Ruggles,	Barras,	"	19
———,—Guides for	Daniel Barnum,	Jersey City,	N. J.	12
———	W. L. Fish,	Newark,	"	12
Sewing-work Holders,	H. G. Scofield,	N. Stamford,	Conn.	19
Shade Fixtures,	F. W. Stafford,	City of	N. Y.	5
Sheet Metal,—Cut'g & Punch'g	E. C. Fraser,	"	"	12
———,—Swaging	W. H. Beach,	Chicago,	Ill.	5
Shoemakers Clamp,	Peter Hanes,	Edina,	Mo.	26
Shutters,—Rolling Iron	J. S. Cochrane,	City of	N. Y.	5
Silk and other Threads,—Sorting	Goodrich Holland,	Willimantic,	Conn.	5
———	"	"	"	19
—— Thread,—Sorting	Atwood & Leigh,	Mansfield Cent.	"	19

Skate Fastenings, .	P. J. Clark, .	W. Meriden,	Conn.	5
Skirts,—Tape for Spring .	T. D. Hoxsey, .	Paterson,	N. J.	12
Sleeve Fasteners, .	Dutee Wilcox, .	Providence,	R. I.	12
Smoking Tubes, .	W. A. Ludden, .	Brooklyn,	N Y.	19
Sowing Machines,	P. D. Cummings,	Portland,	Me.	26
Spoons,—Manufacture of	G. I. Mix, .	Wallingford,	Conn.	26
Springs,—Carriage	E. Roughton, .	Frostburgh,	Md.	26
——,—Metallic .	G. W. McMinn, .	Covington,	Ky.	19
Stave Machine, .	E. and B. Holmes,	Buffalo,	N. Y.	8
Staves,—Chiming and Jointing	Bowker & Bensel, .	City of	"	12
——,—Mak. Wooden Vessels	W. H. Smoote, .	Pr.William co,	Va.	19
Steam Boilers, .	Henry Hoffman, .	City of	N. Y.	26
—— Carriages,—chang. Speed	John Griffin, .	Louisville,	Ky.	19
—— Engines, .	Peter Murray, .	Detroit,	Mich.	19
——— .	S. H. Whitmore,	Cincinnati,	Ohio,	19
———,—Packing for	J. H. Gould, .	Philadelphia,	Penna.	19
———,—condensed st.	Wm. A. Lighthall,	City of	N. Y.	26
———,—Register for	P. L. Weimer, .	Lebanon,	Penna.	26
———,—Condenser for	Cragg & Archbold,	Baltimore,	Md.	19
—— Generators, .	F. E. Schmidt, .	City of	N. Y.	5
Stereoscopes, .	S. D. Goodale, .	Cincinnati,	Ohio,	5
Stereoscopic Pictures, .	Coleman Sellers, .	Philadelphia,	Penna.	5
Stoves, .	S. T. Savage, .	Albany,	N. Y.	19
—— and Ranges,—Cooking	James Spear, .	Philadelphia,	Penna.	19
Stove Covers,—Lifter for	B. R Hathaway,	Mormon Island,	Cal.	26
Straw Cutters, .	Ira Reynolds, .	Bellefontaine,	Ohio,	5
——— .	O. C. Taylor, .	E. Burlington,	Penna.	12
Stuffing Boxes,—Packing for	Ross and Thos. Winans,	Baltimore,	Md.	5
Stump Machine, .	D. W. Henderson,	Deerfield,	Penna.	12
Switches,—Railroad .	J. M. Brahn, .	Red Bank,	N. J.	19
Syringes,—Enema	G. W. Hubbard,	City of	N. Y.	5
Table,—Extension .	T. Q. Hall, .	Fairfield,	Iowa,	5
——,—Folding .	Josee Johnson, .	City of	N. Y.	5
Thread,—Machines for Winding	E. M. Stevens, .	Boston,	Mass.	5
Tile Machines, .	Tiffany & Ingraham,	Palmyra,	Mich.	26
Tire,—Upsetting .	Salmon & Bliss, .	Placerville,	Cal.	19
——— .	C. M. Wilkins, .	W. Andover,	Ohio,	12
Toy Horse, .	J. A. Crandall, .	City of	N. Y.	26
Traps,—Animal .	W. T. Williams,	"	"	19
Troughs,—Cutting Wooden	Arcalous Wyckoff, .	Elmira,	"	19
Type,—Machines for Cutting	J. J. C. Smith, .	Philadelphia,	Penna.	5
Valves of Steam Engines,	Wm. Smith, .	Philadelphia,	Penna.	5
Vapor Burners for Heating, &c.,	R. R. Lewis, .	City of	N. Y.	19
Varnish,—Manufacture of	Frederick Walton, .	Manchester,	Engl'd,	5
Vegetable Cutter, .	M. R. Hubbell, .	Wolcott,	Vt.	19
——— Fibre,—Treating	Gelston Sanford, .	City of	N. Y.	19
Violins, &c.,—Tuning Pegs for	John Albert, .	Philadelphia,	Penna.	5
Washing Machine, .	H. C. Alford, .	Minooke,	Ill.	12
———	C. Carter, .	Franklin Cent.	Iowa,	26
——— .	R. J. Converse, .	Coventry,	N. Y.	26
Waste Matter,—Receptacle for	George Herdtfelder,	City of	"	19
Watchmakers Lathes, .	Chas. Tribby, .	Winchester,	Va.	5
Water Elevators, .	P. Anderson, .	Norwich,	N. Y.	12
——— .	C. H. Dunbrack, .	Jacksonville,	Ill.	12
—— Wheels, .	Ebenezer Tuttle,	Canaan,	Me.	12
Weighing Apparatus, .	A. B. Davis, .	Philadelphia,	Penna.	26
Well, Cisterns, &c.,—Walling	Frederick Wilford,	Eagle,	Wis.	19
Wheels,—Joints of Felloes in	F. M. Gibson, .	Chelsea,	Mass.	5
——,—Spokes and Felloes in	D. A. Johnson, .	"	"	19
Whips, .	J. R. Cannon, .	New Albany,	Ind.	12
Window Sashes,—Hanging, &c.,	H. T. Stanard, .	Wayne,	Mich.	12

Wire,—Harden'g and Temper'g	Ichabod Washburn, .	Worcester,	Mass.	5
Wrench, .	Wm. Mason, .	Warren,	"	26

ADDITIONAL IMPROVEMENTS.

Coupling for Railroad Cars,	A. H. Rowand, .	Allegheny,	Penna.	26
Gas Meters, .	Willson & Fox,	Reading,	"	26
Railroad Cars,—Couch Seats for	John Hartman, Jr., .	Philadelphia,	"	26
Seeding Machines,	F. Chamberlin, .	Berlin,	Wis.	26

RE-ISSUES.

Cars from one track to another,	Wm. Wharton, Jr., .	Philadelphia,	Penna.	19
Clover Separators,	Christian Reif, .	Hartleton,	"	5
Flouring Mills, .	D. S. Wagener, .	Penn Yan,	N. Y.	5
Gin'g Cotton and Bur'g Wool,	S. R. Parkhurst,	W. Bloomfield,	N. J.	12
Knife and Fork Cleaner, .	Sewall Brackett, .	Fall River,	Mass.	5
Ploughs,—Mole .	M. A. Howell, Jr.,	Ottawa,	Ill.	19
Pumps,—Portable .	W. T. Vose, .	Newtonville,	Mass.	26
Sewing Machine Cases,	Ross & Marshall,	City of	N. Y.	26
Ships Winches, .	P. H. Jackson, .	"	"	19
Stoves,—Registers for	S. H. Ransom & Co.,	Albany,	"	19
Timekeepers by Air,—Winding	C. B. Hoard, .	Watertown,	"	19
Willow Peeler, .	J. M. Wood, .	Seneca,	"	26
Window Curtain Fixture,	R. B. Burchell, .	Brooklyn,	"	26

DESIGNS.

Carpet, .	R. Allan, .	Camden,	N. Y.	5
Carpets (2 cases), .	E. J. Ney, .	Lowell,	Mass.	5
—— 16 " .	H. G. Thompson,	City of	N. Y.	12
Stove, .	J. D. Warren and other,	Stamford,	Conn.	5
——,—Cooking .	John Long, .	Massillon,	Ohio,	19
Trade Mark, .	Sampson Hainemann,	City of	N. Y.	26

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, April 18, 1861.

John C. Cresson, President, in the chair.

John Agnew, Vice President.

The minutes of the last meeting were read and approved.

Letters were read from the Royal Geographical Society, London, and the Literary and Philosophical Society of Liverpool, England.

Donations to the Library were presented by the Royal Astronomical Society, the Royal Geographical Society, the Institution of Civil Engineers, the Chemical Society, the Institute of Actuaries, and the Commissioners of Patents, London; the National Observatory and John Lenthall, Esq., Washington City, D. C.; Junius S. Smith, Esq., Buffalo, New York; the Haytian Bureau of Emigration, Boston, Massachusetts; William Wrightson, Esq., Cincinnati, Ohio; H. G. Leisenring, Pennsylvania Legislature, Harrisburgh, Pennsylvania; and Charles E. Smith, Esq., W. Parker Foulke, Esq., James C. Kempton, Esq., H. P. M. Birkinbine, Esq., Wm. A. Rolin, Esq., Prof. John F. Frazer, Prof. John C. Cresson, and the Philadelphia and Reading Railroad Company, Philadelphia.

Donations to the Cabinet.—J. J. Thibault, Esq., presented specimens of gold, silver, and copper ore from Arizona Territory.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of March was read.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (6) were proposed, and the candidates proposed at the last meeting (5) duly elected.

The Actuary reported that the Standing Committee on Meetings have organized by electing Washington Jones, Esq., Chairman for the ensuing year, and appointing the Monday evening previous to the 3d Thursday of each month for holding their stated meetings.

Mr. Meyers, of Messrs. Mitchell, Vance & Co., New York, exhibited a neat sample of an apparatus for lighting gas by electricity. The machine consists of a small glass disc, which revolves between two pads of leather, and gives the generated electricity to points, which are in communication with a brass rod about 12 inches long terminating in a ball. An insulated handle is attached to the lower part of the instrument. A piece of wire, attached to a sheath which slips over the burner, is so adjusted that a spark given to it from the ball of the gas lighter passes through the jet of flowing gas and instantly inflames it.

"Fox's Self-adjusting Drill Chuck" was laid upon the table for the inspection of the members. It consists of a globular piece contained in a chamber formed within another piece which is attached to the spindle of the Drilling Machine. The globular piece has a hole passing through it for the reception of the drill shank, and is so made as to expand when the drill shank is forced into it from the pressure exerted by the feed screw. This pressure is not so great when the drill is just entering the material as to jam the globular piece, and it consequently moves in its socket until the point of the drill is in line with the axis of the spindle, when the greater pressure required to force the increased cutting edge of the drill into the material forces the taper shank into the globular piece, and causes it to expand and become fixed in position.

BIBLIOGRAPHICAL NOTICE.

Annual Report of the Chief Engineer of the Water Department of the City of Philadelphia. Presented to Councils Feb. 21st, 1861.

We extract from this document, which will be found very interesting to our immediate citizens, the following information, which is of general interest, as showing the efficiency of the works and fixing data for calculations for other works of similar character.

Philadelphia is supplied with water by four water-works of different character and locations, but under the charge of the same committee of Councils and Chief Engineer. The amount of work done by

each of these works, with the character of the motors used is given in the following table, which is condensed from those in the Report.

Works.	Average quantity in gallons per day for each month.			Cost of raising 1,000,000 galls. 1 foot high.	Average duty of engine.
	Maximum.	Minimum.	Mean.		
1 Fairmount,	12,446,775 (July.)	7,731,735 (Dec.)	9,867,378	11·7 cts.	[100 lbs. anthr.
2 Schuylkill,	10,812,817 "	4,864,850 "	7,390,849	10·3 "	32,115,800 lbs. per
3 Delaware,	3,015,148 "	1,500,091 (Feb.)	2,379,727	21· "	20,525,800 " "
4 24th Ward,	1,070,435 "	611,165 "	774,112	14·4 "	38,500,800 " "

No. 1. is driven by eight breast wheels, and one Turbine (Jonval); Pumps 16 ins.
No. 2. Two reciprocating overhead beam engines, 36 ins.×6 ft.; Pumps 18 in.×6 ft.
One reciprocating bell crank engine, 36 in.×6 ft.; Pump 21 ins.×6 ft.
One Cornish overhead-beam engine, 60 in.×10 ft.; Pumps 30 in.×10 ft.
No. 3. One horizontal high-pressure engine 30 in.×6 ft.; Pump 18 in.×6 ft.
One beam, condensing engine, 36 in.×6 ft; Pump 18 in. ×6 ft.
No. 4. Two Cornish Bull-engines, 50 in.×8 ft; Pumps 17 in. ×8 ft.
The total supply during the year was, from

Fairmount,	3,612,987,017	gallons.
Schuylkill,	2,696,960,210	"
Delaware,	872,144,980	"
24th Ward,	283,646,070	"
	7,465,738,277	"

The cost of raising the water has been less this year than it was last, and very materially less than that of 1858. Yet the average duty of the engines, which is given as 321,158 lbs. raised 1 ft. high per lb of anthracite, shows that much is yet to be done in the improvement of the steam works while the water-wheels at Fairmount are now far behind our wants, and will be soon replaced.

The report terminates with an account of the experiments made to determine the best form of wheel to be used in the extension of the Fairmount works. We do not propose to go into the details of these experiments, which can scarcely be usefully condensed, but confine ourselves to stating as the general result, that the contract has been given to M. Geyelin of this city, who is the agent for the Jonval Turbine. The subjoined note will give the reasons for this decision.

Department for Supplying the City with Water.
Philadelphia, April 5th, 1861.

Emile Geyelin, Esq.—Dear Sir:—The following are the reasons that influenced the Department in awarding you the contract for furnishing the Jonval Turbine Water Wheels for working the New Pumps at the Fairmount Water Works:—

First: The fact that your model gave the best average per centage over all others brought into competition.

Second: The durability and continued satisfactory operation of your Jonval Turbine erected at Fairmount in 1851.

Third: The general and highly competent evidence brought before the Committee of your ability as a constructor of Turbine Wheels.

Fourth: The fact of your estimate of cost being considerably lower than that of any other party. Yours, respectfully,

Henry P. M. Birkinbine, *Chief Engineer.*

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

THERMOMETRICAL OBSERVATIONS.—The following tables of results have been deduced from observations extending over a period of nine and a half years. The position occupied is in latitude 39° 57′ 28″ N., and longitude 75° 10′ 28″ W. from Greenwich, and fifty feet above high water in the Delaware River. The instruments are protected from radiated and reflected heat, as well as from the direct influence of the sun's rays. The observations were made at 7 o'clock in the morning, 2 in the afternoon, and 9 in the evening.

The warmest days of the year, according to the observations made during this period of time, are the 29th, 30th, and 28th days of June, having the following mean temperatures:—

June 29th,	average mean temperature,	82·0°
" 30th,	" "	81·6
" 28th,	" "	81·3

The coldest days, taking the average temperature for the last ten years, are January 23d, February 3d, and January 9th, with the following means:—

January 23d,	average mean temperature,	24·2°
February 3d,	" "	27·2
January 9th,	" "	27·4

The average temperature of each of the other days of the year, is above 28°.

The warmest day during the whole period of observation was the 21st of July, 1854, of which the mean temperature was 91·3°. The highest degree was reached on the same day, when the thermometer indicated 100·5°.

The coldest day during the same time was the 9th of January, 1856, of which the mean temperature was one degree below zero. The lowest point indicated by the register thermometer was 5½° below zero, on the 23d of January, 1857.

The average temperature of the hours of observation, for every month and season of the year, for ten years, is shown in Table I. The temperature at 7 A. M. is found to be about 4·6 degrees below the mean; at 2 P. M. it is 5·7 degrees above; and at 9 P. M., 1·1 degrees below the mean. The difference of temperature between 7 A.M. and 2 P. M., is less in Winter and greater in Spring than in the other seasons; the average difference in the former season being 8·2°, and in the latter, 11·6°. The average difference of temperature between 2 and 9 P. M., is 4·6° during the Winter months; 7·6 in Spring; and 7·4° in Summer and Autumn.

TABLE I.—*Average mean temperature of the different hours of observation, for the months, seasons, and year; as deduced from observations continued for ten years, at Philadelphia.*

Months.	7 A. M.	2 P. M.	9 P. M.	Mean.
	°	°	°	°
January,	27·24	35·18	30·80	31·07
February,	28·70	37·92	32·93	33·18
March,	35·72	47·34	40·62	41·23
April,	45·58	57·43	49·39	50·80
May,	58·47	69·79	61·61	63·29
June,	69·25	79·29	72·07	73·54
July,	74·10	83·93	76·78	78·27
August,	70·29	80·74	73·37	74·80
September,	62·58	74·91	66·63	68·04
October,	50·97	63·03	55·17	56·39
November,	41·23	50·53	44·45	45·40
December,	31·65	38·91	34·44	35·00
Annual Means,	49·69	59·98	53·19	54·29
Winter,	29·29	37·46	32·83	33·19
Spring,	46·59	58·19	50·54	51·77
Summer,	71·20	81·43	74·01	75·55
Autumn,	51·59	62·82	55·42	56·61

The mean temperature of each month, shown in Table II, is ascertained by taking the average of the mean temperatures of each day; the latter being obtained by averaging the three observations of the day. The mean temperature of the season is ascertained by combining the means of the three months constituting the season; and the mean temperature for the year is obtained by taking the average of the means for each month of the year.

TABLE II.—*Mean temperature of the months, years, and seasons, at Philadelphia, from July,* 1851, *until December,* 1860, *inclusive.*

Months.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	Mean.
	°	°	°	°	°	°	°	°	°	°	°
January,		26·48	33·21	32·91	34·33	23·59	20·92	40·81	34·00	33·41	31·07
February,		33·79	37·80	34·85	26·67	26·73	39·94	30·11	36·43	32·33	33·18
March,		41·19	42·81	43·16	38·80	33·35	38·23	40·67	48·12	44·73	41·23
April,		47·29	53·44	51·39	52·90	54·46	45·44	52·52	50·28	49·48	50·80
May,		64·31	64·29	65·33	63·76	62·66	61·22	59·31	64·65	64·09	63·29
June,		72·87	75·29	73·28	71·87	77·22	71·20	77·54	70·85	71·71	73·54
July,	78·60	78·04	76·60	80·30	79·71	80·06	77·26	79·22	76·00	76·91	78·27
August,	74·18	74·11	75·71	76·65	75·02	72·15	75·26	74·96	74·53	75·43	74·80
September,	68·95	67·33	68·47	70·17	70·20	66·16	69·17	67·92	66·18	65·82	68·04
October,	58·55	58·85	53·93	59·15	55·20	53·42	56·19	59·49	52·32	56·83	56·39
November,	43·55	42·53	48·43	46·12	48·28	43·12	45·86	42·22	47·49	46·39	45·40
December,	30·19	41·73	35·26	31·26	37·50	30·11	41·03	37·65	33·00	32·26	35·00
Annual means,		54·04	55·44	55·38	54·53	51·92	53·48	55·20	54·49	54·12	54·29
Winter,		30·15	37·58	34·34	30·75	29·28	30·32	37·31	36·03	32·91	33·19
Spring,		50·93	53·51	53·29	51·82	50·16	48·29	50·83	54·35	52·77	51·77
Summer,		75·03	75·87	76·74	75·53	76·48	74·57	77·24	73·79	74·68	75·55
Autumn,	57·02	56·24	56·94	58·48	57·87	54·28	57·07	56·54	55·33	56·35	56·61

It will be seen by this table that the warmest year was 1853, but it was only 1·15° above the average temperature for the whole time. The coldest year was 1856, which was 2·37° below the average. The whole range of annual temperatures, or the difference between the warmest and coldest year, was only 3½°. The mean annual temperature of Philadelphia for the nine years from 1852 till 1860, inclusive, is 54·29°.

By the *mean daily oscillation* given in the third table, is meant the average of the differences between the highest and lowest degrees of temperature of each day, as observed by means of the register or maxima and minima thermometer. The difference between the highest and lowest degrees for one day gives the oscillation for that day; the sum of the oscillations for all the days of the month divided by the number of days in the month, gives the mean daily oscillation for the month, as given in the table. The mean daily oscillation for the different seasons is found by taking the average of the oscillations of the three months composing the season; and the mean daily oscillation for the year is ascertained by taking the average of the oscillation for the twelve months composing the year.

It will be seen by the table, that the changes of temperature during the day are about the same in the Spring and Autumn, but that they are nearly four degrees less in Winter than in Summer. The average daily oscillation for the whole time of observation, is 15°.

TABLE III.—*Mean daily oscillation of temperature for every month, season, and year, at Philadelphia, from July,* 1851, *till December,* 1860, *inclusive.*

Months.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	Mean.
	°	°	°	°	°	°	°	°	°	°	°
January,		11·1	12·9	10·2	9·4	11·0	10·3	14·0	13·0	14·8	11·9
February,		10·9	12·3	12·7	10·2	12·7	15·0	14·4	13·2	17·8	13·2
March,		13·8	13·7	12·7	11·9	12·8	15·0	17·1	16·9	18·3	15·2
April,		12·5	18·6	15·7	17·0	17·6	15·8	17·3	15·5	18·9	16·5
May,		16·9	17·3	16·6	17·7	13·2	15·8	14·6	19·7	17·2	16·6
June,		16·0	17·5	16·1	12·8	10·8	14·4	18·3	18·9	18·9	16·0
July,	12·6	15·1	14·6	14·2	12·0	18·6	14·5	17·2	20·2	19·8	15·9
August,	14·5	13·3	14·8	14·6	11·5	20·0	15·3	16·1	20·5	18·8	15·9
September,	16·1	16·4	14·7	13·6	14·9	20·9	17·5	19·7	18·1	18·2	17·0
October,	16·2	14·4	15·9	13·1	13·4	17·0	15·0	17·3	18·1	16·1	15·6
November,	9·7	10·7	13·0	10·3	10·9	17·3	16·9	12·3	18·6	14·4	13·4
December,	10·5	11·5	12·2	10·2	11·7	12·3	13·4	11·8	14·2	12·2	12·0
Annual means,		13·6	14·8	13·4	12·8	15·3	14·9	15·8	17·2	17·1	15·0
Winter,		10·8	12·2	11·7	10·4	11·8	12·5	13·9	12·7	15·6	12·4
Spring,		14·4	16·5	15·0	15·5	14·5	15·5	16·3	17·4	18·1	15·9
Summer,		14·8	15·6	15·1	12·1	16·5	14·7	17·2	19·9	19·2	16·1
Autumn,	14·0	13·8	14·5	12·3	13·1	18·4	16·5	16·4	18·3	16·2	15·3

By the *mean daily range* given in the fourth table, is meant the change of temperature from one day to the next. It is ascertained by taking the average of the differences of temperature between the two days at the several hours of observation. Thus, if we suppose the observed temperatures to be as follows:—

1860,	December	1st,	7 A. M.,	36½°	2 P. M.,	34°	9 P. M.,	32°
"	"	2d,	"	30	"	35½	"	35
	Differences,			6½°		1½°		3°

of which the average is 3·7°, which is called the mean daily range for the 2d of December. The average of all the results obtained in this way for a month, gives the mean daily range for the month; and the average of the results for the different months, gives the mean daily range for the season, or for the year, according to the months taken. From this table, it will be seen that the difference of temperature between one day and the next, is greatest in the winter months, reaching its maximum in February, and least in the summer months, arriving at its minimum in July and August. The annual means differ but eight-tenths of a degree between the highest and lowest, from 5·2° in 1858, to 6° in 1856 and 1859.

TABLE IV.—*Mean daily range of temperature, for every month, season, and year, at Philadelphia, from July,* 1851, *till December,* 1860, *inclusive.*

Months.	1851.	1852	1853	1854.	1855.	1856.	1857	1858.	1859.	1860.	Mean.
	°	°	°	°	°	°	°	°	°	°	°
January,		6·4	5·5	8 6	6 7	6·5	7·7	5·9	8·0	6·5	6·9
February,		6·2	7·2	8·0	5·8	8·1	9·2	6·1	6·3	8·8	7·3
March,		7·0	6·5	6·5	5 8	5·3	6·4	6·0	6 0	5·4	6·1
April,		4·8	6·3	7 2	7·1	6·6	6·0	7·0	6·3	7·4	6·5
May,		5·1	6·6	5·1	5·2	7·0	4·8	5·5	5·7	5·2	5·6
June,		4·8	4·7	4·4	4·2	4·7	4·2	4·4	6·1	4·2	4·6
July,	3·1	3·6	3·5	3·6	3·9	3·9	2·9	3·7	4·6	5·0	3·8
August,	3·3	3·7	4·0	4 6	3·5	4 1	3·2	4·4	3·1	3.8	3·8
September,	4·4	4·5	4·3	6·1	5·4	5·0	4 6	4·1	4·1	5 2	4·8
October,	5·0	5·6	5 9	4·9	5·8	7·3	4·3	5·3	5·9	5·8	5·6
November,	3·9	5·0	6·5	5 9	5·2	7·8	7·1	3·5	7·3	5·5	5·8
December,	4 5	7·1	6·1	6 5	6·4	6 3	5·7	6·3	8·4	5·0	6·4
Annual means,		5·3	5·6	5 9	5·4	6·0	5·5	5·2	6·0	5·6	5·6
Winter,		6·4	6·6	7·6	6 3	7·0	7·7	5·9	6·9	7·9	6·9
Spring,		5·6	6·5	6·3	6·0	6·3	5·7	6·2	6·0	6·0	6·1
Summer,		4·0	4·1	4·2	3·9	4·2	3·4	4·2	4·6	4·3	4·1
Autumn,	4·4	5·0	5·6	5·6	5·5	6·7	5·3	4·3	5·8	5 5	5·4

The fifth table contains the extreme monthly, annual, and quarterly range of the thermometer. The extreme monthly range of tempera-

ture is found by taking the difference between the highest and lowest degree indicated by the thermometer during each month; the quarterly range is found by subtracting, in the same manner, the lowest from the highest degree indicated by the thermometer during the quarter; and the annual range shows the difference between the maximum and minimum for each year. The last column contains the average differences for each month, season, and year.

TABLE V.—*Extreme monthly, annual, and quarterly oscillation of temperature, for every month, year, and season, together with the average oscillation for each month, &c., from July, 1851, till December, 1860, inclusive, at Philadelphia.*

Months.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	Mean.
	°	°	°	°	°	°	°	°	°	°	°
January,		52·0	43·0	46·5	46·0	47	43·5	40	57	54·5	47·7
February,		48·5	44·5	45	47·5	46	59	42	45	69	49·6
March,		49·0	53	53	48	45	54	61	50	48	51·2
April,		37·0	45	57	65	57	44·5	51	47	52	50·6
May,		41·5	43	49	47	44·5	44·5	35	43	46	43·7
June,		46	47	47	44	44	38	43·5	54	41	44·9
July,	29·0	32	34	37·5	38	40	38	35·5	43	38·5	36·5
August,	33·5	30·5	39	39	29	50	34	36	45·5	40	37·6
September,	52·5	42·5	50	47	45	51	43	47	36·5	50	46·4
October,	40	50	40	45	43	50	42	55	51·5	43	45·8
November,	37	34	43	42	39	46	59	44	40	64	44·9
December,	45	42	45	42	47	49	45	48	62	36·5	46·2
Annual means,		98	88	94·5	96	105	99·5	86·5	99	94·5	95·7
Winter,		64	53	50	63	65	73·5	53	65	70	61·8
Spring,		63·5	70	63	71	79·5	77·5	74	67	65	70·1
Summer,		46	47	51·5	44	53	44	43·5	55	43·5	47·5
Autumn,	66	59	70	67	62	67	68	66	55	76	65·6

MARCH.—The temperature of the first three days of March, 1861, was unusually high, reaching 78½° on the afternoon of the 3d. The highest point reached previously during this month, in the last ten years, was 75°, in March, 1854. During the morning of the 4th, the wind changed from the south-west to the north-west, and the temperature fell rapidly. At 2 P. M., it was 19° lower than at the same hour on the preceding day; and at 2 P. M., on the 5th, it was 19° lower than at the same hour on the 4th. So that the difference of temperature at that hour, in two days, amounted to 38°.

On the 9th of the month, rain began to fall early in the morning, and continued until 3 P. M., when the sky cleared off beautifully, and continued clear all the evening. At about 8 P. M., a splendid *aurora* was observed. It first appeared like a bright greenish light, extending from about 10° above the northern horizon, to a height of 40°. At 9 P. M., streamers appeared of a greenish hue at the north, and red towards the north-east and north-west, extending up to beyond

the Great Bear, which was then but very little east of the meridian. At 9¼, green streamers appeared, reaching up to irregular and unequal heights, some of them extending as high as the constellation of the Great Bear. The whole of the northern half of the sky was illuminated. The light was green in the north, and red towards the east and west. At 9¾, a bright detached pencil of white or greenish white light was observed, stretching from the east directly west, about 10° south of the zenith, about 3° in width; red light in the north-west. At 10 P. M., the auroral light was still visible, but no streamers or pencils, and the light was gradually fading away.

On the 14th, the temperature fell to the freezing point in the morning, and at 9½ A. M., a fine snow began to fall, which continued till 1 P. M., when it was about two inches deep on the ground. At that time it changed to a drizzling hail, and soon afterwards to rain, which continued till 6 P. M., when the snow re-commenced. It stopped some time during the night. This snow-storm extended towards the south as far as Georgia. At Norfolk, Va., it commenced early on the 15th. It reached Augusta, Ga., on the night of the 18th, where it is reported to have fallen to the depth of six or eight inches.

On the 19th, snow to the depth of about one inch, fell at Philadelphia. About 8 P. M. on the 20th, snow began to fall, and continued at intervals until 11 P. M. on the 21st, melting as it fell. It began at about the same time at Easton, Pa, and extended from Norfolk, Va., to beyond St. Johns, N. B. At noon on the 19th, it was reported to be twelve inches deep at Norfolk. At Boston on the 21st, it was said to have been the thickest snow-storm of the season. On the 19th at Bangor, Me., the snow in the streets was from two to four feet deep, and the fields were covered to the depth of three feet. A letter from St. John, N. B., dated March 24th, states that there was then at least seven feet of snow on the level, while in the streets of the city, it was from twelve to fifteen feet deep.

On the 27th, rain began to fall early in the morning, and continued with great violence until 4½ P. M. It was accompanied by thunder and lightning from 11½ A. M. till 12 M., and from 2½ till 4 P. M. At 3 P. M., a very bright flash of lightning, which appeared to be of a reddish hue, was followed almost instantly by an extraordinarily sharp and loud clap of thunder.

The average temperature of the month, as will be seen by the following table, was two degrees lower than that of March of 1860, but still more than a degree above the average for the last ten years.

The mean daily range, showing the changes of temperature from day to day, was more than two degrees greater than usual.

The thermometer reached its maximum of 78½° on the 3d of the month, which was also the warmest day, the mean temperature being 66°.

The minimum temperature was 16°, and occurred on the 18th of the month. The coldest day was the 18th, the mean temperature being 23°.

The range of temperature for the month was 62½°.

The temperature was below the freezing point on fifteen days of the month, but it rose above that point some time during every day, except on the 18th and 19th, when the highest point reached was 30½°.

The pressure of the atmosphere was greatest (30·386 ins.) on the morning of the 8th, and least (29·354 ins.) on the afternoon of the 9th; making the range for the month, 1·032 inches. The mean pressure was greatest on the 8th and least on the 3d of the month. The mean daily range or average of changes of pressure was four-hundredths of an inch greater than usual, and one-tenth of an inch greater than it was in the month of March of last year.

The force of vapor and relative humidity were less, though the amount of precipitation in the form of rain and snow was greater than usual. The quantity of rain and melted snow (3·903 ins.) was thrice as much as that which fell in March, 1860, and over an inch more than the average for the last ten years. Snow fell on four days, and rain on five days of the month. The number of rainy days was nine, being one less than the average number for the month of March.

There were but two days on which the sky was entirely clear or free from clouds, and two on which the sky was completely covered with clouds, at the hours of observation.

A Comparison of some of the Meteorological Phenomena of March, 1861, *with those of March,* 1860, *and of the same month for ten years, at Philadelphia.*

	March, 1861.	March, 1860.	Mar., 10 years.
Thermometer.—Highest,	78·5°	73·0°	78·5°
" Lowest,	16·0	25·0	4·0
" Daily oscillation,	18·18	18·30	15·04
" Mean daily range,	8·66	5·40	6·36
" Means at 7 A. M.,	37·73	38·15	35·92
" " 2 P. M.,	48·71	52·34	47·48
" " 9 P. M.,	41·58	43·71	40·72
" " for the month,	42·67	44·73	41·37
Barometer.—Highest,	30·386 in.	30·224 in	30·522 in.
" Lowest,	29·354	29·499	29·158
" Mean daily range,	·231	·133	·195
" Means at 7 A. M.,	29·917	29·829	29·853
" " 2 P. M.,	29·862	29·757	29·796
" " 9 P. M.,	29·906	29·795	29·830
" " for the month,	29·895	29·794	29·826
Force of Vapor.—Means at 7 A. M.,	·175 in.	·171 in.	·166 in.
" " " 2 P. M.,	·182	·175	·183
" " " 9 P. M.,	·185	·182	·182
Relative Humidity.—Means at 7 A. M.,	69 per ct.	71 per ct.	73 per ct.
" " " 2 P. M.,	48	44	53
" " " 9 P. M.,	66	61	67
Rain and melted snow,	3·903 in.	1·323 in.	2·700 in.
No. of days on which rain or snow fell,	9	8	10
Prevailing winds,	s 73°37′w ·328	s 79°17′w ·224	s 76°25′w ·312

Abstract of Meteorological Observations for February, 1861; made in Philadelphia, Adams, and Franklin Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

	Philadelphia.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. Kirkpatrick, Observer.											Gettysburg, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Ht. 624 ft. Prof. M. Jacobs, Obs.					Chambersburg, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. Wm. Heyser, Jr., Observer.						
1861.	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Dew point.	Clouds.	Rain and snow.	Prevail'g winds.	Barom	Thermom.		Rain and snow.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Dew point.	Rain and snow.	Prevail'g winds.
Feb.	Mean.	Mean daily range	Mean.	Daily oscillation.	Mean daily range.	2 P. M.	2 P. M.	2 P. M.	Sky cover'd			Mean.	Mean.	Mean daily range.			Mean.	Mean.	Mean daily range.	2 P. M.	2 P. M.	2 P. M.		
	Inch.	Inch.	°	°	°	Inch.	Per ct.	°	Tenths.	Inch.	Direc.	Inch.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Per ct		Inch.	Direc.
1	29·975	·033	30·5	18	7·3	·134	64	24·9	8	0·470	(var.)	29·456	21·3	5·7	0·651	W.	29·283	24·3	5·3	·083	54	13·9	0·435	(var.)
◐ 2	29·640	·336	47·8	14	17·3	·347	96	49·0	10		S W.	29·186	40·3	19·0		S W.	29·027	42·7	18·3	·251	84	40·3		W.
3	30·127	·487	36·3	6	11·5	·127	60	23·7	10		N N W	29·699	33·7	6·7		N W.	29·534	33·7	9·0	·127	61	29·7		(var.)
4	30·156	·085	33·2	8¼	3·8	·177	80	31·5	5		N W.	29·739	30·0	3·7		(var.)	29·561	31·7	2·7	·136	62	25·0		(var.)
5	30·051	·105	36·3	15	3·5	·131	49	24·4	6		W.	29·610	26·0	4·0		S S W.	29·455	30·7	1·7	·165	72	29·6		E.
6	29·768	·283	38·3	16	2·7	·099	52	18·1	1		S S W	29·301	35·7	6·3		S W.	29·135	37·0	6·3	·113	42	21·0		W.
7	29·593	·375	27·8	35	13·5	·200	78	24·5	7	0·047	S S W	29·196	19·3	17·7		N W.	29·042	22·7	17·7	·050	31	4·0		W.
8	30·397	·804	8·2	17	25·3	·046	68	1·4	1		W N W	29·955	4·7	20·7		(var.)	29·760	8·0	19·3	·043	59	—0·2		W.
● 9	30·451	·073	27·7	22	19·5	·100	54	18·3	8		S E.	29·985	25·3	20·7		S.	29·777	24·3	16·3	·100	65	18·3		(var.)
10	30·397	·145	46·7	23	19·0	·280	69	43·2	9		S.	29·884	39·0	13·7		S S W.	29·696	35·3	11·0	·203	82	34·9		E.
11	30·069	·238	52·3	16	5·7	·334	69	47·9	9		S.	29·524	46·3	7·3		S S W.	29·337	48·3	13·0	·251	61	40·5	0·250	E.
12	29·882	·387	54·2	16	6·5	·288	49	43·9	5	0·495	(var.)	29·252	46·7	6·3	0·690	W N W	29·090	50·3	8·0	·153	37	27·9		W.
13	30·019	·338	46·5	18	7·7	·115	26	21·4	4		W.	29·571	38·3	8·3		W.	29·438	42·0	8·3	·166	49	29·9		E.
14	29·937	·165	41·7	14	4·8	·161	46	29·1	6	0·452	(var.)	29·469	37·0	3·3	0·830	N N E.	29·332	39·3	4·0	·156	49	28·4	0·515	E.
15	29·529	·409	41·0	6	4·7	·234	91	38·5	10		N E.	29·016	39·3	3·0		N W.	28·874	41·0	3·0	·228	76	38·0		E.
16	29·609	·245	44·7	21	5·0	·153	36	27·9	6	0·083	W.	29·030	36·0	3·3		S S W.	29·059	38·7	3·7	·134	41	24·8	0·445	E.
◑ 17	29·595	·246	38·7	13	6·0	·111	39	29·6	6		W N W	29·128	32·7	3·3		N W.	28·935	33·0	5·7	·142	70	26·3		W.
18	29·810	·215	33·3	9¼	5·3	·127	60	23·7	7		S W.	29·388	29·3	3·3		W N W	29·240	32·0	1·0	·085	43	14·9		W.
19	29·910	·147	34·3	14	1·7	·115	47	21·5	6		W.	29·432	29·0	3·0	0·210	S S W.	29·203	32·3	3·0	·085	43	14·9	0·150	E.
20	29·569	·342	3·8	13	5·5	·157	53	28·6	8	0·322	W.	29·132	35·3	6·3	0·040	(var.)	28·984	37·3	5·7	·208	75	35·4	0·050	W.
21	29·773	·208	35·0	9	4·8	·069	25	7·1	2		W.	29·394	31·3	4·0		N W.	29·245	34·3	4·3	·149	70	27·3		W.
22	30·047	·270	38·5	16	6·2	·080	27	13·4	5		(var.)	29·583	35·3	4·0		W.	29·423	38·0	6·3	·112	34	20·8	0·100	E.
23	29·728	·319	50·3	22	11·8	·225	47	37·5	10	0·255	(var.)	29·206	44·3	9·0		S S W.	29·056	36·3	8·3	·186	52	32·7		E.
◯ 24	29·848	·242	39·7	27	17·7	·089	41	15·9	5		W S W	29·460	31·3	18·3		N W.	29·334	32·3	14·0	·149	70	27·4		W.
25	30·300	·452	33·2	18¼	9·5	·088	33	15·6	0		S W.	29·814	30·7	6·7		S S W.	29·652	31·3	7·0	·103	45	19·0		(var.)
26	30·118	·182	45·0	24	11·8	·242	48	34·8	5		S S W	29·702	39·7	7·0		S S W.	29·499	43·0	11·7	·131	29	24·4		W.
27	30·152	·058	52·3	25½	7·3	·219	34	35·8	3		S W.	29·731	46·0	6·3		(var.)	29·564	47·0	4·3	·177	34	31·5		W.
28	30·064	·088	56·2	26½	3·8	·345	50	48·8	3		W N W	29·631	52·7	6·7		W.	29·477	51·3	4·7	·203	32	34·9		W.
Means	29·939	·264	39·5	17¼	8·9	·169	52¼	27·9	6	2·124	S 77° W	29·481	34·0	8·1	2·421	S 87° W	29·331	36·0	8·0	·146	54	25·3	1·945	N 59° W

Abstract of Meteorological Observations for February, 1861; made in Somerset, Dauphin, and Northumberland Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1861. Feb.	Somerset, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. Geo. Mowry, Observer.									Harrisburg, Dauphin Co. Lat. 40° 16′ N. Long. 76° 50′ W. Height, 300 feet. John Heisely, M.D., Observer.									Shamokin, Northumberland Co.—Lat. 40° 45′ N. Long. 76° 30′ W. Height, 700 feet. P. Friel, Observer.								
	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P. M.	Relative humidity. 2 P. M.	Dew point. 2 P. M.	Clouds. Sky covered.	Rain and snow.	Prevail'g winds.	Barom. Mean	Thermom. Mean	Thermom. Mean daily range.	Force of vapor. 2 P. M.	Relative humidity. 2 P. M.	Dew point. 2 P. M.	Rain and snow.	Prevail'g winds.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of Vapor. 2 P. M.	Relative humidity. 2 P. M.	Dew point. 2 P. M.	Rain and snow.	Prevail'g winds.
	Inch.	°	°	Inch.	Per ct.	°	Tenths.	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	°	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	°	Inch.	Direc.
1	27·447	31·0	13·7	·175	89	31·7	10	0·343	S.	29·763	25·3	2·7	?	?	?	} 0·358	(var.)	29·274	21·0	1·5	·120	61	22·4	0·371	E.
☾ 2	27·330	44·0	13·7	·285	85	43·3	10		W.	29·433	41·3	16·0	·264	92	41·7		E.	28·908	45·2	24·5	·291	89	44·2		E.
3	27·595	27·7	16·3	·153	88	28·7	10		WNW	29·991	37·0	4·3	·172	72	30·7		(var.)	29·467	32·8	12·3	·142	70	26·2		W.
4	27·808	29·3	1·7	·147	78	28·3	7		(var.)	30·016	32·7	4·0	·177	80	31·5		N E.	29·409	31·7	5·2	·103	45	19·0		W.
5	27·721	32·3	3·0	·234	91	38·7	10		W.	29·897	34·0	2·0	·207	90	35·4		S E.	29·594	28·3	4·0	·123	57	23·0		(var.)
6	27·475	32·7	5·7	·130	55	27·3	5		W.	29·505	38·3	4·3	·162	58	29·3		S W.	29·061	36·7	8·3	·097	39	17·7		W.
7	27·527	17·3	24·7	·097	92	18·8	9	0·186	WNW	29·440	28·0	15·0	·158	70	23·6		N W.	28·578	31·0	15·0	·177	86	31·5		W.
8	27·870	9·3	22·0	·103	75	21·3	5		S W.	30·203	9·7	21·0	?	?	?		N W.	29·608	9·3	30·7	·036	72	−4·2		W.
● 9	27·910	28·3	19·0	·260	78	41·0	8		S.	30·306	27·3	17·7	·143	79	26·4		E.	29·685	21·3	21·0	·106	86	19·5		E.
10	27·901	45·7	17·3	·315	71	45·5	8		S.	30·165	38·3	11·0	·211	82	35·9		E.	29·502	43·3	22·0	·260	78	41·3	0·062	S E.
11	27·577	50·7	6·3	·362	87	49·3	10		S.	29·856	48·7	10·3	·347	93	49·0		S	29·209	53·3	10·0	·362	87	50·1		E.
12	27·411	41·7	9·0	·188	56	34·0	2		W.	29·510	48·3	5·7	?	?	?	} 0·055	W.	29·058	49·3	6·0	·407	87	53·2	0·765	W.
13	27·705	37·7	4·0	·188	56	34·0	4		W.	29·848	42·3	6·0	·206	85	44·7		S W.	29·296	37·7	11·7	·228	76	37·9		W.
14	27·522	39·7	3·3	·238	77	39·0	10	0·395	E S E	29·784	40·7	2·3	·272	84	42·5		N E.	29·270	36·3	2·7	·105	41	19·5	0·090	W.
15	27·202	37·3	2·3	·215	79	37·2	10	0·267	(var.)	29·320	40·0	3·3	·257	100	41·0	} 0·360	(var.)	28·985	39·5	5·5	·235	91	38·7		E.
16	27·222	31·3	2·7	·183	90	32·7	7	0·341	S E.	29·592	41·7	2·3	·223	69	37·3		S W.	28·870	40·5	6·3	·258	77	38·9		E.
☽ 17	27·243	30·7	6·3	·170	80	31·3	9	0·084	W.	29·417	38·7	6·0	·142	62	26·3		W.	28·808	33·3	8·5	·162	80	29·3	0·500	W.
18	27·507	29·3	7·3	·121	75	24·3	10		W.	29·659	33·0	2·7	·177	80	31·5		W.	29·054	29·2	4·2	·136	78	25·2		W.
19	27·475	28·0	4·7	·169	84	31·5	10	0·076	(var.)	29·710	38·7	1·3	·148	70	27·2		(var.)	29·134	31·0	1·8	·168	89	30·2		W.
20	27·274	37·0	9·0	·169	84	32·0	10		W.	29·399	39·0	5·3	·207	75	35·4	0·312	N W.	28·703	35·8	4·8	·110	49	20·4	0·190	W.
21	27·571	28·0	9·0	·103	45	24·0	5	0·025	W.	29·653	36·0	3·0	·150	63	27·5		N W.	29·031	30·3	5·5	·170	80	30·5		W.
22	27·686	39·7	11·7	·196	52	34·7	10		S W.									29·304	32·0	5·7	·129	61	24·0		W.
23	27·350	53·3	13·7	·234	59	45·5	10		S W.	29·492	45·0		·250	84	40·3		E.	28·951	45·3	14·3	·260	78	41·3	0·100	E.
○ 24	27·677	22·7	30·7	·074	57	17·0	8		WNW	29·721	30·7	12·3	·164	71	● 29·6		N W.	29·079	31·8	14·8	·168	89	30·2		N W.
25	27·868	32·3	20·3	·165	49	31·7	4		S.	30·126	34·0	8·7	·158	64	28·8		S W.	29·543	28·7	12·2	·170	80	30·5		S W.
26	27·811	45·7	13·3	·230	55	37·7	5		(var.)	29·951	38·7	4·7	·211	82	35·9		S W.	29·342	39·7	11·0	·231	83	38·2		W.
27	27·881	48·3	2·7	·309	60	43·7	5		W.	30·026	45·7	7·7	·206	61	41·9		S W.	29·451	44·0	11·7	·329	77	54·7		W.
28	27·834	53·3	5·0	365	60	47·5	5		W.	29·921	52·0	6·3	·397	71	52·6		S W.	29·363	48·8	4·8	·478	83	57·8		W.
Means	27·587	35·6	10·7	·203	70	34·0	8	1·715	s 64° w	29·859	37·2	7·2				1·625	s 79° w	29·185	34·9	10·1	·201	63	31·8	2·078	s 80° w